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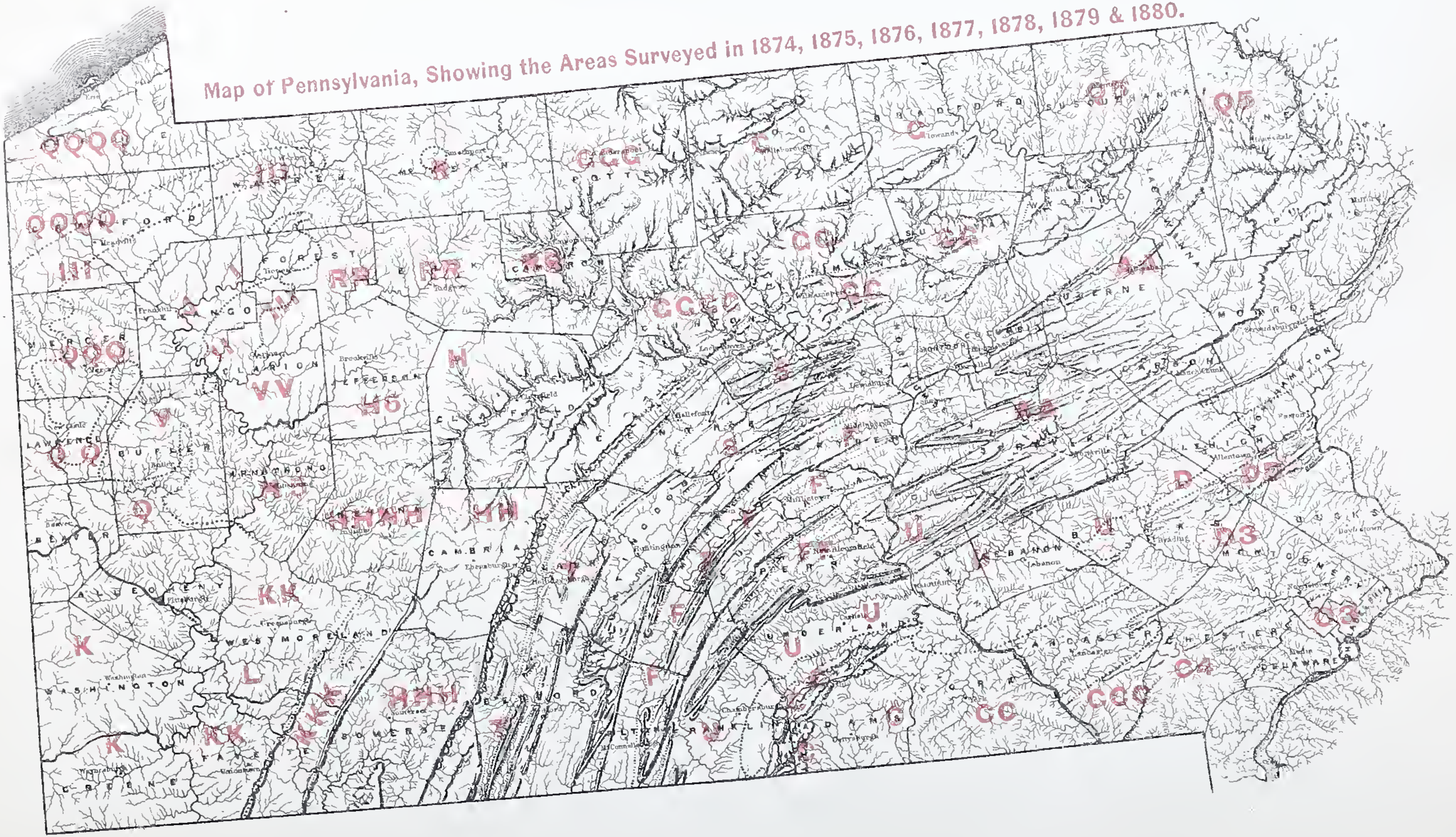

SECOND GEOLOGICAL SURVEY OF PENNSYLVANIA:

REPORT OF PROGRESS

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THE GEOLOGY OF SUSQUEHANNA COUNTY AND WAYNE COUNTY.

By I. C. WHITE.

WITH A
GEOLOGICALLY COLORED MAP,
AND 58 SECTIONS.

HARRISBURG:
PUBLISHED BY THE BOARD OF COMMISSIONERS
FOR THE SECOND GEOLOGICAL SURVEY.
1881.

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LETTER OF TRANSMITTAL.

To His Excellency Governor Henry M. Hoyt, chairman of the Board of Commissioners of the Second Geological Survey of Pennsylvania :

SIR : I have the pleasure to submit the Report of Progress of the Survey in Susquehanna and Wayne counties, in 1880, by Prof. I. C. White.

The principal feature of this report is its classification of the Pocono and Catskill formations, with definite names bestowed, virtually for the first time, on their sub-divisions, or several groups of beds.

This is an important step in the progress of American geology. It has not been know that any such classical differentiation of these thick deposits was practicable. Mr. White has however succeeded in establishing numerous fixed horizons, well defined both by lithological and palæontological marks ; and when, during the field season of 1881, he shall have traced the outcrops of these sub-divisions from Pike county westward to the West Branch of the Susquehanna river, we shall be in condition to devise a pretty complete nomenclature for the hitherto unnamed sub-divisions of formations VIII, IX and X in middle Pennsylvania, where their combined thickness varies from 10,000 to 12,000 feet.

This great desideratum has been necessarily postponed to the closing years of the Survey.

I beg to call your attention especially to Mr. White's description of the flat-pebble conglomerates, and to the calcareous breccias, or cornstones, of the district reported on, and to the importance of the latter named rocks to its agriculture.

The two counties under review in this book are uncommonly barren of mineral resources; neither coal, nor iron ore, nor any other kind of ore existing either at the surface or at a moderate depth. The Marcellus brown hematite ore beds, and the Clinton fossil iron ore beds, if they were deposited within the limits of the district, lie buried now at depths varying in different parts of it between 1000 and 5000 feet.

Although the Venango Oil formation is represented by a group of beds underlying the whole of Wayne and the greater part of Susquehanna county, there is very little to support an expectation of success in boring for oil.

The great salt bearing (*Pocono* No. X,) rocks of the southwestern counties form in this district a few ranges and patches of highland; and the salt bearing rocks of the State of New York (*Salina*, No. V) lie nearly as deep beneath the surface as the fossil ore beds.

It is possible that at some future time salt brine may be obtained in abundance from wells 3000 feet deep sunk to the *Salina* rocks in the northern townships of Wayne county, and in the northwestern and middle townships of Susquehanna county; and certainly a deep trial-hole should be bored to test the existence of thick rock-salt deposits at that depth. When such an enterprise is contemplated a pretty exact calculation can be made of the probable depth of the *Salina* formation beneath any chosen locality. The salt shafts of the Rhine valley 3500 feet deep afford sufficient evidence that where beds of rock salt are known certainly to exist great depth is not a bar to exploitation.

Another feature of this report is its frequent description of glacial phenomena:—surface deposits of northern and local *Drift* gravels, sand and clays—moraine ridges and dams of *Drift* in valleys,—crystalline rock fragments in the *Drift* of one small area,—innumerable bowlders and huge isolated blocks of the country-rocks scattered loosely or closely over the whole district,—and scratches and grooves made by the *Mer de glace* on the rock-surfaces, pointing southward and southwestward, at all elevations up to 2100 feet above tide level on the side of Mount Ararat;—and references to all Mr. White's observations on this interesting topic will be found collected in Index B under the head of "Glacial drift."

I am obliged to repeat what I said in my letter prefixed to Report Q^4 on Erie and and Crawford counties, that as Prof. White's manuscript report exhibits views of the erosive ability of moving ice such as those entertained by the ultra glacialists, and in my opinion mischievous (in a purely scientific sense,) I have made myself responsible for the removal from the printed text of most of the sentences which embody those views, seeing that they are not statements of fact, but simply expressions of feeling and hypothetical inferences. All his observed facts are given in the text, and the reader is left at liberty to draw his own conclusions, unbiassed by glacial theories.

With great respect,
Your obedient servant,
J. P. LESLEY.

1008 Clinton street, Philadelphia,
June 17, 1881.

LETTER

Prof. J. P. Lesley,
State Geologist:

Dear Sir: I herewith transmit my report on Wayne and Susquehanna counties.

Field work was commenced about the middle of June and continued until the 20th of September. During the last three weeks of my stay in the field an attempt was made to trace the *Cascade sandstone* westward, for the purpose of determining, if possible, its relations to the *Carrollton* and *Salamanca conglomerates.* It was successfully traced into Bradford county and there correlated with the "*Chemung*

(*Fall's creek*) *conglomerate*" of Sherwood. An accident prevented further progress.

Owing to the scarcity of exposures further west, it will be very difficult to follow the *Cascade sandstone* from Fall's creek towards Lake Erie; but the evidence for its parallelism or identity with the *Panama conglomerate*, (*3d oil sand of Venango*,) which I adduce in my report, is so strong that this identity seems to me fully established. The important conclusions flowing from this identification are fully stated in the Summary, or first part of my Report.

The Survey is under special obligations for various acts of kindness in connection with my work in the two counties, to the Hon. C. C. Jadwin, Prof. Jno. W. Dolph, and Wm. Muir of Honesdale; Mr. Richardson of Great Bend and Mr. Jno. S. Hines of Scranton. For season passes and other favors the Survey is indebted to Mr. C. F. Young of the D. & H. C. Co., Mr. E. S. Bowen of the Erie RR., Mr. Samuel Sloan of the D., L. & W. RR., Mr. Chas. Latimer of the N. Y., Pa. & Ohio RR., and Mr. Jno. B. Smith of the Penna. Coal Co.'s RR.

Very respectfully,
Your obedient servant,
I. C. WHITE.

W. VA. UNIVERSITY, MORGANTOWN,
April 20, 1881.

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SUSQUEHANNA AND WAYNE COUNTIES.

CHAPTER I.

GEOGRAPHY.

Area; population; towns.

SUSQUEHANNA COUNTY lies between Bradford county and the northern half of Wayne, along the New York State line, 33⅝ miles; its northeast corner being 120 perches west from the 6th mile stone; and its northwest corner at the 40th mile stone.

Its western line runs due north and south along the Bradford county line 24¼ miles.

Its eastern line runs north and south along Wayne county exactly 24¾ miles.

Its southern boundary along Wyoming and Lackawanna counties is therefore not quite parallel to the northern or State line.

Its *area* is 797 square miles, or 510,080 acres.*

The county is sub-divided into 27 townships arranged in the following order:—

Apolacon. Choconut. Silver Lake. Liberty. Great Bend. Oakland. Harmony.
Franklin.
Middletown. Forest Lake. New Milford. Jackson. Thompson.
Bridgewater.
Jessup.
Rush. Ararat.
Brooklyn. Harford. Gibson.
Dimock. Herrick.
Auburn. Springville. Lathrop. Lenox. Clifford.

Its *population* for the last three decades, according to the census reports, is as follows:

In 1860,	36,267
In 1870,	37,523
In 1880,	40,351

---

* Gray & Walling's Atlas.

Its *principal towns* are:

Montrose, the county seat, situated in Bridgewater township, on very high ground, at the head of East Wyalusing creek, 4 miles west from the actual center of the county. Its population in 1870 was 1,463 and in 1880, 2,110; its chief industry is the manufacture of agricultural implements, carriages, and toys. The Montrose Narrow Gauge R. R. gives it business connection southward with Tunkhannock, and the Lehigh Valley R. R. Level above tide, (station grade) 1646′; summit of hill at the Fair grounds 1850′.

Susquehanna Depot, on the Susquehanna river in Oakland township, is a very thriving town; it is a division station on the line of the N. Y., L. E. & W. (Erie) R.R., and very extensive machine and repair shops are located there, giving employment to several hundred men. Its population in 1870 was 2,729, and in 1880, 4,500. Besides the Erie R.R. it has direct business connection with the Anthracite coal fields by way of the Jefferson Branch R.R. to Carbondale, 35 miles south. Level above tide (station grade) 914′.

Great Bend is situated on both banks of the Susquehanna river in the township of same name, where the river makes the great curve which carries it back to the State of New York. Its population in 1870 was 855 and in 1880 ——. The Erie R.R. along the north bank of the Susquehanna, and the D. L. & W. R.R. along the south bank of the same. give ample business connections. It is best known from its extensive tanneries; level above tide, Erie R.R. grade, 884′. D., L. & W. R.R., 876′; level of Susquehanna river, 860′.

Towns and villages in Susquehanna county, with distance from Montrose and elevation above tide, are as follows:

	Miles.		*A. T.*
Ararat, Ararat township,	19.9	E.	2023′
Auburn Center, Auburn township,	12.6	S. W.	1390′
Auburn Four Corners, Auburn township,	9.4	S. W.	—
Brackney, Silver Lake township,	10.9	N.	—
Brookdale, Liberty township,	10.9	N. N. E.	—
Brooklyn, Brooklyn township,	6.5	S. S. E.	1180′
Cascade Bridge, Harmony township,	18.9	N. E.	—
Choconut, Choconut township,	11.4	N. N. W.	1100′
Clifford Corners, Clifford township,	19.8	S. E.	—
Dimock, Dimock township,	6.1	S.	1507′
Dundaff, Clifford township,	21.4	S. E.	1620′

	Miles.		*A. T.*
Fairdale, Jessup township, ...	4.5	W. S. W.	1145′
Forest Lake, Forest Lake township, . .	4.2	N. W.	1560′
Friendsville, Middletown township, . .	10.1	N. W.	1550′
Gibson, Gibson township, ...	12.3	E.	1225′
Glennwood, Lenox township, ...	15.1	S. S. E.	850′
Grangerville, Rush township, ...	10.	W. S. W.	1025′
Harford, Harford township, ...	10.	E. S. E.	1275′
Herrick, Herrick township, ...	19.1	E. S. E.	1803′
Foster, Lenox township, ...	10.6	S. S. E.	890′
Jackson, Jackson township, ...	15.1	W.	—
Lanesboro, Harmony township, ...	18.1	E. N. E.	982′
Lawsville Center, Liberty township, . .	7.8	N.	1085′
Lenox, Lenox township, ...	14.1	S. E.	–
Lenoxville, Lenox township, ...	17.6	S. E.	1040′
Little Meadows, Apolacon township, . .	16.8	N. W.	1075′
Lynn, Springville township, ...	12.0	S. S. E.	1210′
Middletown, Middletown township, . . .	11.0	W. N. W.	1060′
Montrose Depot, Harford township, . . .	5.7	E. S. E.	1050′
New Milford, New Milford township, . .	8.8	E. N. E.	1084′
Niven, Springville township, ...	12.3	S.	—
Oakley, Harford township, ...	9.2	S. E.	942′
Rush, Rush township, ...	10.3	W. S. W.	—
Silver Lake, Silver Lake township, . . .	7.9	N.	1585′
Smiley's, Gibson township, ...	16.1	E. S. E.	1115′
South Gibson, Gibson township, ...	14.9	S. E.	1010′
Springville, Springville township, . . .	9.5	S.	1257
St. Joseph, Choconut township, ...	7.9	N. W.	—
Summers, New Milford township, ...	9.3	N. E.	1010′
Thompson Center, Thompson township, .	19.4	E.	1703′
Uniondale, Herrick township, ...	22.1	E. S. E.	1693′
Upsonville, Franklin township, ...	7.2	N. E.	1620′
Franklin Forks, Franklin township, . .	6.3	N. E.	1055
West Auburn, Auburn township, ...	13.9	S. W.	—

WAYNE COUNTY in the northeastern corner of Pennsylvania, lies between Susquehanna county and the Delaware river.

Its boundaries as given by Mr. John Torrey of Honesdale, civil engineer and author of a map of Wayne county, are as follows:

From the New York State line its eastern boundary follows the meanders of the Delaware river down to Big Eddy, a distance (by the stream) of 45 miles.

From Big Eddy the line between Wayne and Pike runs S. 31¾° W. 10 miles, 23 poles, to the mouth of Wallenpaupack creek;—thence up the Wallenpaupack to where the South Branch is crossed by the North and South Turnpike, a distance (by the stream) of about 40 miles;—thence due west 7 miles, 92 poles to Lehigh creek;—thence up Lehigh creek "to the head forks thereof" 6 miles.

Its west boundary along Lackawanna (lately Luzerne) county and Susquehanna county runs due north 48 miles 274 poles to the New York State line. (Susquehanna county borders it for 24¾ miles.) Its north boundary along the New York State line back to the Delaware river is 6⅜ miles.

Its *area* as compiled from official surveys of all the tracts is according to Mr. Jacob S. Davis 462,615 acres, or 722.8 square miles.*

Its 20 townships are arranged in the following manner:

Scott.
Buckingham.
Preston.
Manchester.
Mt. Pleasant. Lebanon. Damascus.
Clinton. Dyeberry. Oregon.
Canaan. Texas. Berlin.
S. Canaan. Cherry Ridge.
Palmyra.
Salem. Paupack.
Sterling.

Its population according to the census reports has been:

In 1860,	32,239
In 1870,	33,188
In 1880,	33,512

Its principal towns are:

Honesdale, the county seat, situated in Texas township, on Lackawaxen creek, at the mouth of the Dyeberry.—Its population in 1870 was 2,654, and in 1880, 7,000; it is the western terminus of the Delaware and Hudson Canal, and is best known as a shipping point for anthracite coal, which is conveyed across the Moosic mountains from Carbondale on the Carbondale & Honesdale Gravity R.R. The coal is re-shipped on the D. & H. Canal, and the branch of the N. Y. L. E. & W. R.R. (Erie) which decends the Lackawaxen creek from Honesdale to the Delaware river connecting the town directly with New York and the eastern cities.

Level of water in D. & H. Canal 985′ A. T. Honesdale

---

* Walling & Gray's atlas says 720 square miles; 460,800 acres.

Gravity R.R. track, in Depot 1000′, Erie R.R. depot one mile below, 966′, (see Report N.)

Hawley, on Lackawaxen creek, at the mouth of the Wallenpaupack, 9 miles below Honesdale, is another great re-shipping point for the anthracite coal trade, since it is the terminus of the Penn'a Coal Co.'s Gravity RR. which crosses the Moosic range from Dunmore where it connects with the Pittston and Scranton Coal fields; the coal that it brings from this Lackawanna basin is re-shipped at Hawley for the east on the Erie Branch RR. to Lackawaxen on the main Erie line 16 miles distant.—Population 1870 2,500, in 1880 ——; level above tide at RR. grade 899′.

Bethany, 3 miles north from Honesdale, and once the county seat of Wayne, is situated on an elevated ridge between the waters of Lackawaxen (west) and Dyeberry creek (east),—elevation of old Court House square 1440′ A. T.

Villages in Wayne county, with distance from Honesdale and elevation above tide, are as follows:

	Miles.		*A. T.*
Aldenville, Clinton township,	7.	N. W.	1240′
Ariel, Salem township,	10.4	S. W.	—
Beech Pond, Berlin township,	5.5	E. N. E.	1330′
Berlin Center, Berlin township,	2.2	N. E.	1250′
Belmont, Mt. Pleasant township,	14.7	N. W.	2040′
Clark's Corners, Cherry Ridge township,	3.2	S.	1175′
Cold Spring, Lebanon township,	10.4	N.	1600′
Damascus, Damascus township,	12.7	N. E.	—
Dyeberry, Dyeberry township,	3.8	N.	—
East Sterling, Sterling township,	18.	S.	1360′
Equinunk, Buckingham township,	19.	N.	—
Galilee, Damascus township,	12.6	N.	—
High Lake, Buckingham township,	16.4	N.	1260′
Hawley, Palmyra township,	7.5	S.	899′
Hamlinton, Salem township,	13.5	S. W.	—
Hollisterville, Salem township,	15.3	S. W.	—
Howe's Valley, Sterling township,	18.5	S. S. W.	—
Indian Orchard, Texas township,	2.6	S.	995′
Jericho, Buckingham township,	18.9	N.	—
Little Equinunk, Manchester township,	18.3	N.	—
Ledgedale, Salem township,	14.2	S. S. W.	1170′
Middle Valley, Cherry Ridge township,	5.7	S. W.	—
Milanville, Damascus township,	11.2	E. N. E.	—
New Baltimore, Scott township,	28.7	N.	—
Narrowsburg, Berlin township,	9.9	E.	714′
Nobleville, Sterling township,	16.9	S. S. W.	—
Newfoundland, Sterling township,	19.2	S. S. W.	1335′

	Miles.		*A. T.*
Preston, Preston township, ...	17.8	N.	—
Priceville, Manchester township, . . .	16.1	N. N. E.	—
Pleasant Mount, Mt. Pleasant township,	14.2	N. N. W.	2025′
Prompton, ...	3.3	N. W.	1095′
Purdytown, Paupack township, ...	8.5	S.	—
Rileyville, Lebanon township, ...	9.5	N.	1715′
Rock Lake, Mt. Pleasant township, . . .	12.9	N.	—
Starrueca, Preston township, ...	24.	N. N. W.	1424′
Stockport, Buckingham township, . . .	21.5	N.	896′
South Canaan, S. Canaan township, . .	9.1	W. S. W.	1400′
South Sterling, Sterling township, . . .	20.3	S. S. W.	1465′
Sand Cut, Sterling township, ...	24.2	S. S. W.	—
Tanner's Falls, Dyeberry township, . .	6.1	N.	1140′
Waymart, Canaan township, ...	7.5	W.	1551′

CHAPTER II.

TOPOGRAPHY.

Mountains, rivers, railroad levels, lakes and ponds.

The topography of the surface of the two counties considered as one district is much diversified and made irregular by erosion.

This would be strikingly illustrated to anyone who should make a day's journey over any of the roads of the district which do not follow the water courses; our traveler would find his journey a constant succession of ascents and descents; that no sooner had he reached the summit of one hill than he would have to descend it on the other side, while the level stretches would be few and far between.

The *Elk mountains*, a northeastern extension of the Mahoopeny, form a very striking feature in southeastern Susquehanna; the *North Knob* and *South Knob* being visible from the hilltops in most portions of the county, and attaining an altitude of 2700′ A. T.

The *cliff sandstones* of the *Catskill series* frequently form a succession of steep bluffs, with sloping benches, shale occupying the intervals; stand out uncovered with soil and surface débris in bold successive cliffs along the hillsides; or cap the higher summits with broad sheets of massive sandrock.

Thus, the *North Knob* has been preserved from destruction by its coping layer of hard massive sand rock; the solitary peak standing 2700′ above tide in the midst of a much lower surrounding country, while the valleys around it have been excavated 1500′ below its summit.

The highest land of the district makes a belt from 5 to 6 miles wide along the Susquehanna-Wayne county line in a northward prolongation of the mountain walls of the Carbondale coal basin.

As nearly all the water-ways cut down through the *Catskill cliff sandstones* their slopes are usually quite steep, and the valley beds themselves very narrow. The valley of the Delaware river is a fine example, with its narrow waterway, its gorge-like cross section, and its high steep sidewalls made by the horizontal sandstone edges of the Catskill strata.

In striking contrast to this is the broad and gently sloping valley of the Susquehanna river flowing between low rolling hills of soft Chemung rocks.

The Moosic divide:—While the water courses of Susquehanna county drain wholly into the Susquehanna river, by streams which flow northward, southward, westward and southwestward, the water courses of Wayne county drain wholly eastward and southeastward into the Delaware river; except a small area in the northwest corner, which drains northwestward.

The middle county line is therefore along a grand divide, represented by the Moosic mountain range, a northward prolongation of the united mountain walls of the Carbondale coal basin.

The following are the principal streams of the district, with short descriptions of their direction and character; but the reader is referred to the map which accompanies this report for specific details.

The Susquehanna river enters the district from New York at the northeastern corner of Susquehanna county, but after going south five miles it turns abruptly west and, after continuing about 10 miles makes its Great Bend and passes northward back into New York. There it again veers west, and flows roughly parallel to the State line, and from 3 to 10 miles north of it, to the mouth of the Chemung river at Waverly. Here it bends south into Bradford county, which it crosses to its southeast corner and so keeps on southeastward across Wyoming county into Luzerne. Where it enters Wyoming county it is only 4 miles from the southwest corner of Susquehanna county; thus making a great circle from the Great Bend round through Bradford county.

Its rate of fall is shown by the following levels taken along the New York & Erie R.R. and the Lehigh Valley R. R. (See Report N.)

New York and Erie railroad levels.

	Miles.	*A. T.*	*A. T.*
Susquehanna Depot,		914′	water about 875′
Great Bend,	9	884′	“ “ 860′
Binghamton,	14	864′	
Hooper,	6	839′	
Union,	2	834′	
Campville,	7	830′	
Owego,	7	822′	
Tioga,	5	805′	
Smithboro,	5	799′	
Waverly,	9	836′,	water about 740′

Lehigh Valley railroad levels.

	Miles.	*A. T.*	
Waverly,	—	836.0′	
Sayre,	2	773.8′	
Athen's Bridge,	2	778.8′	
Ulster,	8	742.8′	
Towanda,	7	737.8′,	water 699.8′
Wysauking,	4	718.5′	
Standing Stone,	4	702.0′	
Rummerfield,	3	696.2′	
Frenchtown,	4	689.8′	
Wyalusing,	6	674.2′	
Laceyville,	10	657.8′	
Black Walnut,	3	649.0′	
Meshoppen,	5	643.9′	river level 609′
Mehoopany,	3	634.5′	
Vosburg,	7	615.5′	
Tunkhannock,	5	610.8′	
Lagrange,	4	597.6′	
McKime's,	3	597.6′	
Falls,	4	587.3′	
Ransom,	6	579.2′	
Lackawanna Junction,	5	569.8′	river level 535′

Rate of fall per mile.

	Fall.	*Miles.*	*Rate.*
Susquehanna depot to Waverly,	120′	64	1′ 11″
Waverly to Towanda,	40′	19	2′ 1″
Towanda to Meshoppen,	91′	35	2′ 7″
Meshoppen to Lackawanna Junction,	74′	37	2′ 0″
Susquehanna Depot to Lackawanna Junction,	340′	155	2′ 2″

The east and west divide which extends entirely across

Susquehanna county is highest at the east, and from its northern slope many streams pass northward into the Susquehanna river.

Starrucca creek, which drains the northeastern corner of Susquehanna, rises on the highest portion of this east and west divide; flows northward, and empties into the Susquehanna river at Lanesboro'. The descent of its bed from the high divide is shown by the following levels on the Jefferson Branch of the Erie railroad which descends the same:

Jefferson Branch railroad levels.

	Miles from Lanesboro'.	*A. T.*
Ararat Summit,	16	2023′
Thompson,	11	1703′
Starrucca,	8	1424′
Webster's Mills,	3	1297′
Steven's Point,	1¾	1078′
Brandt's,	¾	1047′
Nineveh Junction,	—	981′
Lanesboro' Junction,	0	982′
Mouth of Starrucca creek, (Susquehanna river,)	—	880′

The streams rising on the southern slope of the east and west divide also reach the Susquehanna river. The Lackawanna river rises just on the south side of the divide opposite Starrucca creek, and its descent southward through Susquehanna and Lackawanna counties to the Susquehanna at Pittston, is shown by the following tables: The Jefferson Branch railroad southward from Ararat and down the Lackawanna valley to Carbondale gives the slope thus:

Jefferson Branch railroad levels.

	Miles from Summit.	*A. T.*
Ararat Summit,	—	2023′
Herrick,	6	1803′
Uniondale,	8	1693′
Forest City,	14	1481
Carbondale, (Lackawanna railroad,)	19	1079′
Jermyn,	26	968′
Archbald,	27	965′
Olyphant,	30	807′
Providence, (Lackawanna river,) D. L. & W. R. R.,	33	700′
Scranton,	35	740′
Taylorville,	—	683′

Lackawanna Junction,	41	573′
Pittston,	44	573′
Level of Susquehanna river, (Pittston,)	44	535′

Rate of fall: 1488′ in 44 miles; or 33′.9 per mile*.

The profile across the center of the east and west divide is given by the levels on the Del. Lack. & West. R. R. as follows:

Delaware, Lackawanna and Western railroad levels.

	Miles.	*A. T.*
Binghampton in New York,	0	843′
Conklin in New York,	8½	849′
Corbettsville in New York,	—	852′
New York and Pennsylvania State line,	12	860′
Great Bend,	14	876′

At this point the R. R. leaves the Susquehanna valley and turns south up Salt Lick creek, the rise of whose valley is shown by the following:

New Milford,	20½	1084′
Summit cut at head of Salt L. creek,	22 (Bar.)	1150′

The R. R. here passes through a great gap in the divide, the summits of the hills on either side rising 500′ higher than the railroad bed. From this summit (1150′) the R. R. descends the valley of Martins creek with the following slopes:

Montrose Depot,	27¼	1050′
Oakley's,	32¼	942′
Foster,	34¾	890′
Nicholson,	40½	766
Level of Tunkhannock, mouth Martin's creek,	—	700′

At this point the line of the D. L. & W. R. R. leaves the water-way, and ascending the divide between Tunkhannock waters and the Lackawanna, passes across the Lackawannock mountains through a gap into the Lackawanna coal basin, thus:

Tunnel,	44½	963′
Factoryville,	46½	917′
Abington,	51¾	1055′
Clark's Summit,	54¾	1239′
Scranton,	62	740′

From Scranton this road leaves the Lackawanna valley, passing up Roaring Branch, through its gap in the Moosic mountain range, and crosses over the high Pocono divide to the Delaware river at the famous Water Gap. From Scranton along this line the levels are as follows:

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*As measured along the railroads which follow the stream closely.

		Miles.	*A. T.*
Greenville,		—	1182′
Dunning's,		—	1397′
Moscow,		75	1555′
Summit,		—	1887′
Gouldsboro', Wayne county,		83	1880′
Tobyhanna,		89	1929′
Summit,	*Descends face of Pocono mountain.*	—	1970′
Paradise,		—	1518′
Oakland,		102	1008′
Henryville,		—	593′
Spragueville,	Down Broadhead creek.	—	487′
Stroudsburg,		115	400′
Delaware Water Gap,		119	316′
Level of Delaware river at Walker's Ferry,		—	298′
Portland,		—	288′
Delaware bridge,		127	290′
Manunka Chunk, (Phila. & Trenton R. R.,)		129	320′
Level of Delaware river here,		—	262′

Montrose railroad levels.

The general slope of the surface south from the east and west divide is probably better shown by the levels on the Montrose R.R. than any other, since it does not follow the valley of any particular stream, but cuts across several valleys, and descends southward with the surface slope. It begins just south from the summit of the divide and connects Montrose with the Susquehanna valley, at Tunkhannock.

Montrose, (station,)	0		1656′
Summit of hills just north,	—	(Bar.)	1850′
Allenville,	—		1649′
Coal's,	—		1547′
Hunter's,	—		1547′
Dimock,	11		1507′
Tylerville,	—		1400′
Springdale,	14		1257′
Lynn,	19		1032
Meshoppen creek,	—		933′
Avery,	—		979′
Lemon,	—		1041′
Marcy,	—		965′
Tunkhannock, (junction with L.V. R. R.,)	28		611′

New York & Erie railroad levels.

The valley of the Delaware river from Port Deposit down southward has a rate of fall shown by the railroad which follows its bank.

	Miles from N. Y.	*A. T.*
Summit Cut*,	183	1373′
(Hill tops north and south of cut),	—	(1900′)
Deposit,	176	1009′
Hale's Eddy, (north line of Wayne co.,)	171	974′
Dickinson,	168	954′
Hancock,	163	926′
Stockport,	158	896′
Lordville,	152	864′
Bouchon,	149	850′
Basket,	145.5	830′
Hawkins,	142	809
Rock run,	138	787′
Callicoon,	135	781′
Cohecton,	130	748′
Nobody's.	125	748′
Narrowsburg, (south line of Wayne,)	121	714′
Pine Grove,	116	668′
Lackawaxen,	115	648′
Shohola,	106	648′
Pond Eddy,	93	571′
Port Jervis,	87	440′

Rate of fall (569′ in 90 miles) 6′ .3 per mile. Air line distance 60 miles; rate of air line fall say 9½′ per mile.

Honesdale Branch railroad levels.

The *Lackawaxen* valley from its head to the Delaware descends at a rate (obtained by Barometric levels, combined with railroad levels along the Honesdale Branch of the Erie) as follows:

	Miles.	*A. T.*
Belmont Lake,	0	1950′
Mt. Pleasant, (distance by stream,)	3	1835′
Fowler's mill, " "	4½	1725′
J. D. Wheeler's, " "	6¼	1560′
O. Kelley's " "	7	1470′
Mrs. Vastbinder's, " "	8¼	1375′
G. H. Tennant's, " "	10¼	1300′
Aldenville, " "	14¼	1200
Prompton, " "	18¼	1090′
Honesdale, " "	22¼	975′

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*In the dividing Chemung ridge between the Delaware and Susquehanna rivers.

Honesdale Station, (Erie R. R. grade,) . . .	23	966′
White Mills, " " " . . .	27	925′
Hawley, " " " . . .	32	899′
Kimble's, " " " . . .	34	849′
Millville, " " " . . .	40	780′
Rowland's, " " " . . .	44	700′
Lackawaxen, " " " . . .	48	650′
Delaware river here, ...	—	600′

Rate of fall: Belmont lake to Lackawaxen 1350′ in 48 miles=28′.2 p.m.

Pennsylvania Coal Company railway levels.

The profile of the Moosic mountain range, or the great north and south divide, is given by the Penna. Coal Co.'s Gravity R.R. which crosses it from Hawley to Dunmore (near Scranton), as follows:

Empty track leaving Hawley	*Above Tide.*
Hawley, ...	896′
Head of Plane No. 13, 1st from Hawley, ...	1078′
" " " 14, 2d "	1207′
" " " 15, 3d "	1300′
" " " 16, 4th "	1397′
" " " 17, 5th "	1441′
" " " 18, 6th "	1552′
" " " 19, 7th "	1565′
" " " 20, 8th "	1519′
" " " 21, 9th "	1607′
" " " 22, 10th " . .	793′
" " " 23, 11th " (Pittston,).	631′

This empty track passes through a great gap in the Moosic mountain cut by Roaring Branch, so that it does not show the general elevation of that range. The returning loaded track from Pittston to Hawley passes directly over the Moosic system where no gap exists, and there it shows the following profile:

Foot of Plane 1, (Pittston,)	567′
Foot of Plane 1, ...	675′
" " 2, ...	773′
" " 3, ...	813′
" " 4, ...	964′
" " 5, ...	1062′
" " 6, (Dunmore,)	1117′
" " 7, ...	1268′
" " 8, ...	1455′
" " 9, ...	1644′
" " 10, ...	1822′

Base of Plane 11,	1784′
Tunnel head of Plane 11,	1967′
Summit of mountain above tunnel, (by bar.,)	2025′
Base of Plane No. 12,	1346′
Head “ “	1496′
Hawley,	896′

Carbondale and Honesdale railroad levels.

About 12 miles north from where this railroad crosses Moosic we get another profile along the line of the Honesdale and Carbondale Gravity R.R. which crosses the range through Rix's gap. The general elevation of the crest of Moosic between the Penna. Co's loaded track and Rix's gap is from 2100′—2200′ A. T.

	A. T.
Carbondale, lower end,	1012′
Head of Plane 1,	1252′
“ “ 2,	1389′
“ “ 3,	1591′
“ “ 4,	1774′
“ “ 5, (Summit of Moosic,)	1935′
“ “ 6,	1918′
“ “ 7,	1584′
Foot “ 7,	1452′

From foot of Plane 7 to Honesdale, a distance of about 10 miles, the grade descends at the rate of 44½′ per mile which gives the A. T. level of

Honesdale, ... 1000′

Empty track back from Honesdale.

Head of Plane 1,	1180′
“ “ 2,	1178′
“ “ 3,	1290′
“ “ 4,	1424′
“ “ 5,	1502′

Note.—Since Report N was published, the (track on both the empty and loaded roads) has been changed somewhat, so that this list of elevations is not now applicable to the Planes. A more complete and detailed statement of the levels along the present tracks was kindly sent to me from the records of the company in Honesdale by Mr. Wm. Muir, of the D. & H. C. Co., and is placed on a separate page.

Plane No. 1 begins at Carbondale and crosses the Moosic range to Honesdale at foot of the 12 Level, whence the empty

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TABLE *of Planes and Levels on Delaware and Hudson Canal Company's Gravity Railroad.*

Planes.	Levels.	Length of Planes.	Length of Levels.	One foot in.	Grade per mile.	Rise.	Fall.	Elevation Tide Base.	Planes.	Levels.	Length of Planes.	Length of Levels.	One foot in.	Grade per mile.	Rise.	Fall.	Elevation above Tide Base.
		ft.	ft.	ft.	ft.	ft.	ft.	ft.			ft.	ft.	ft.	ft.	ft.	ft.	ft.
1		1479		12.39		119.39		1194.14	15		1312		7.51		174.65		1264.67
	1		1648		51.49		16.07	1178.07		15		6673		44.21		55.87	1208.20
2		1435		13.54		105.95		1284.02	16		1027		6.26		164.02		1372.22
	2		238		33.50		1.51	1282.51		16		10572		44.81		89.72	1282.50
3		1310		11.34		115.53		1398.04	17		2169		11.68		185.70		1468.20
	3		556		50.14		5.28	1392.76		17		6869		42.09		54.76	1413.44
4		1320		10.07		131.20		1523.78	18		1760		12.78		137.72		1551.16
	4		239		58.98		2.67	1521.11		18		1068		48.00		9.71	1541.45
5		1294		9.95		130.00		1651.11	19		2680		11.21		234.43		1775.88
	5		209		50.53		2.00	1649.11		19		295		59.24		3.31	1772.57
6		1253		11.73		110.19		1759.30	20		1560		11.68		133.95		1906.52
	6		216		51.33		2.10	1757.20		20		74281		72.52		1020.30	886.22
7		1410		13.88		101.61		1858.51	21		1146		14.66		78.19		964.41
	7		1809		46.09		15.79	1843.02		21		14214		63.74		171.59	792.82
8		1257		12.07		104.15		1947.17	22		418		10.45		40.00		832.82
	8		4895		46.79		43.38	1903.79		22		8860		48.45		81.30	751.52
9		1369		11.64			117.61	1786.18	23		1352		10.87		124.43		875.95
	9		242		108.44		4.97	1781.21		23		9329		44.08		77.89	798.06
10		1320		11.31			116.87	1664.34	24		1462		11.93		122.50		920.56
	10		100		148.90		2.82	1661.51		24		4790		44.50		40.37	880.19
11		1342		11.69			114.75	1546.77	25		1080		10.62		101.70		981.89
	11		1193		64.09		14.48	1535.29		25		8248		44.06		68.82	913.07
12		1463		12.23			119.64	1415.65	26		1863		15.61		161.20		1074.27
	12		52194		43.57		430.65	985.00		26		552		44.00		4.60	1069.67
13		985		5.06		194.50		1179.50	27		1658		10.47		158.42		1228.09
	13		14238		46.79		126.18	1053.32		27		25673		42.42		206.26	1021.83
14		629		6.13		102.55		1155.87	28		1008		14.05		71.75		1093.40
	14		7879		44.53		66.45	1089.42		28		2137		46.08		18.65	1074.75

car track returns across the same mountain reaching the summit (1906′.52 A. T. at head of Plane 20, which is 41′ lower than the summit (1947′.17) on the loaded track at head of Plane 8.

The end of the 20th Level is at Archbald in the Lackawanna valley. Plane 23 is at Olyphant; Planes 22 and 24 at Peckville; Planes 25, 26, & 27 at Archbald; Plane 28 at Carbondale.

From Rix's gap northward, the Moosic range varies from 2000′–2200′ in height until we come to Griswold's gap, opposite the southeast corner of Susquehanna county, where it is cut down to 1950′ (barometer). Going still northward from this it rises higher again and continues at an elevation of 2050′–2100′ to beyond Mt. Pleasant, just north from which however it begins to get more elevated, and finally culminates in the lofty Ararat peak, whose summit I determined by barometer at 2650′ above tide, the second highest elevation in northeast Pennsylvania.

A low valley of erosion intervenes just north from Ararat and then the Moosic range apparently ends with Sugar Loaf peak whose summit, (by barometer) is 2475′ A. T. North from this the general level of the divide is about 2000′, and it continues in a very sinuous course northward between the Delaware and Susquehanna rivers.

Rivers and Creeks.

Two great divides, one *North and South*, the other *East and West*, not only separate the drainage of the district into two systems, one belonging to the Delaware water tree, and the other to that of the Susquehanna; but also subdivide the latter into two subordinate water basins, one debouching northward, the other southward.

The *Starrucca*, *Canawacta*, *Drinker's*, *Mitchell's*, *Salt Lick* and *Wiley creeks* empty northwards into the Susquehanna within the State; *Snake*, *Choconut* and *Apolacon creeks*, not until they have entered New York State.

The streams which drain the southern slope of the *east and west divide* into the Susquehanna, are the following, beginning at the east:

Lackawanna river, which flows south along the eastern line of Susquehanna county (draining the western slope of the Moosic mountains) cuts straight through the Lackawannock range at the southeastern corner of Susquehanna county and, entering the Lackawanna coal basin, flows down its trough southwest to the Susquehanna river at Pittston. The slope of this valley has already been given under the head of R. R. levels.

Tunkhannock creek with its numerous tributaries comes next west from the Lackawanna river, and drains a large area from the southern slope of the *east and west divide*, southwestward, into the Susquehanna river at Tunkhannock, in Wyoming county. The main tributaries of this stream are the *East Branch*, emptying into it near the southern line of the county, and *Martin's creek* which flows southward from the great gap in the *east and west divide* near New Milford, emptying into Tunkhannock two miles south from the county line at Nicholson.

The descent of this stream is shown by the following barometric elevations:

	Miles.	*A. T.*
Divide at head of Tunkhannock creek,	0	1600′
Level of creek near D. A. Lamb's,	4	1250′
“ “ “ Gelatt P. O.,	6	1150′
“ “ “ Smiley P. O.,	8½	1075′
“ “ at South Gibson,	12½	1000
“ “ “ mouth of Partner's creek,	15	925′
“ “ “ Glenwood P. O.,	20	815′
“ “ “ Nicholson, (Wyoming county,)	23	700′
“ “ “ Tunkhannock, (Susquehanna R.,)	38	580′

Meshoppen creek and its tributaries, *Little Meshoppen*, *White* and *Riley creeks*, drain the remaining portion of the southern slope of this divide.

Tuscorora creek, which empties into the Susquehanna near Laceyville, drains the extreme southwest corner of the county.

Wyalusing creek rises on the elevated plateau near Montrose, and flowing westward with a rapid fall drains with its tributaries (the *North* and *Middle Branches*) a large area out of the central western portion of Susquehanna Co.

The following barometric elevations show the descent of its bed westward:

Head at Montrose, (summit of divide,)	0	1850′
Level of creek at west line of Montrose borough,.	—	1550′
“ “ east line of Jessup township, . .	2½	1240′
“ “ Fairdale P. O., ...	5	1105′
“ “ near R. Reynolds’, ...	9	1010′
“ “ opposite W. L. Vaughn’s, ...	11	950′
“ “ at Rushville (west line of Susque.)	14	850′
“ “ Susquehanna R. near Wyalusing,	26	645′

The drainage eastward from the great *north and south divide* into the Delaware river, is also divisible into two systems.

The north and south watershed splits as it goes southward. Its main branch keeps due south. The other veers off southeastward, and keeping rudely parallel to the Delaware (6 to 7 miles west from it) passes into Pike county and ends in a long narrow ridge at the Delaware river near Lackawaxen.

The streams on the eastern slope of this subordinate watershed are mostly small, and descend with a very rapid fall directly to the Delaware. They are the following beginning at the north:

Strawder's creek, heading up against Starrucca, and flowing northeast through Scott township.

Chehocton, heading up against Starrucca, in Preston, and flowing northeast to the Delaware at Hancock.

Big Equinunk heads against the tributaries of Lackawaxen, and also flows northeast to the Delaware at Equinunk.

Little Equinunk takes its rise in Duck Harbor Pond at the north-east line of Lebanon Tp. and descends at a very rapid rate north-eastward to the Delaware.

Holisters, *Cashe's*, and *Calkin's creeks* flow eastward into the Delaware in Damascus township.

Mast Hope creek drains the southern portion of Berlin, through the northeast corner of Pike county to the Delaware river.

The western slope of this water-shed as well as the eastern slope of the main *north and south divide* (Moosic mounttains) is drained by *Lackawaxen creek* and its tributaries. This drainage basin constitutes about two-thirds of the area of Wayne county; hence the Lackawaxen carries a large amount of water. Its principal tributaries are:

Dyeberry empties into it from the north at Honesdale;

Middle Branch comes in from the west at Hawley;

Wallenpaupack, from the south, pours a large volume of water into it at the same locality over the cliffs of Paupack Falls.

A very insignificant area at the extreme south-eastern corner of Wayne is drained by a tributary of the Lehigh river.

Lakes and Ponds.

A peculiarity of the drainage systems in both Wayne and Susquehanna, but especially in Wayne, is the great number of ponds and lakelets clustered around the heads of the streams, and principally at the summits of the water-sheds.

There are probably seventy-five of these in Wayne, varying in size from an acre of surface up to 150. Many of them are surrounded by dry banks of gravel extending down to the water's edge, with no streams draining into them, and only a narrow channel cut down through the gravel heap for the outlet. Of course such a pond can be fed only by springs rising from its bottom. Others again have small feeding streams, and are often surrounded by a great expanse of *swamp* or *marshy lands*, thus indicating the probable greater expanse of the water in the past.

The Delaware & Hudson Canal Co. has taken advantage of these ancient drained lake basins to secure a constant supply of water for their canal from Honesdale to the Delaware river, during the dry seasons of summer and fall. By throwing high dams across the narrow outlets of several lakelets tributary to the Lackawaxen, the surplus rainfall of winter and spring is thus caught and stored up to be gradually let out through wickets in the dams when needed in the summer.

The following are the principal lakelets and ponds in Susquehanna, with their elevation above tide (by barometer,) and depth where known:

	Townships.	*Depth.*	*Above Tide.*
Meadow Lake,	Apolacon,	—	1575′
Wyalusing Lake,	"	—	—
Stanley Pond,	Choconut,	—	—
Choconut Pond,	"	—	—
Quaker Lake,	Silver Lake,	—	1450′
Mud "	"	—	1550′
Silver "	"	—	1650′
Cranberry Lake,	"	—	—
Meaker Pond	"	—	—
Tripp lake,	Liberty,	85′	1430′
Brushville Pond,	Oakland,	—	1305′
Comfort's,	Harmony,	—	—
Wrighter's,	Thompson,	—	1950′
Butler Lake,	Jackson,	—	1665′
North Jackson Pond,	"	—	—
Page Pond,	New Milford,	—	1400′
East Lake,	"	—	—
Tucker Pond,	"	—	1290′
Hart Lake,	"	—	1540′
Upper "	"	—	1400′
Jones' "	Bridgewater,	30′	1580′
Brown's Pond,	"	—	1415′
Forest Lake,,	Forest Lake,	—	1560′
Bixbee Pond,	Middletown,	—	—
Elk Lakes,	Dimock,	—	1350′
South Pond,	Brooklyn,	—	—
Middle Lake,	Harford,	—	1365′
Lower "	"	—	1350′
Tingle "	"	—	—
Tyler "	"	—	1325′
Blanding Lake,	"	—	—
Willis "	Gibson,	—	—
Stearn's "	"	—	—
Brundagee's Lake	"	—	—
Fiddle "	Ararat,	—	—
Dunn "	"	—	2100′±100′
Low "	Herrick,	—	1905′
Lewis "	"	—	1700′
Crystal "	Clifford,	120′	1750′
Long Pond,	"	—	—
Round "	"	—	—
Mud "	"	—	—
Stillwater Pond,	"	—	1525′
Robinson Lake,	Lennox,	—	—
Loomis "	"	—	—
Patrick "	"	—	—
Tarbell Pond,	Lathrop,	—	—
Lord "	"	—	—
Field's "	"	—	—
Coy's, "	Springfield,	—	—
Stales "	"	—	1100′

The following lakelets and ponds are found in Wayne county:

4 Mile Pond,	Scott,	. . . .	—	—
Island "	"	. . . .	—	1800′

In Preston township which lies immediately south from Scott, the lakelets are very numerous as may be seen by consulting the map. At my request Hon. N. F. Underwood, member of the State Assembly from Wayne, and a resident of Preston, undertook the determination of the maximum depths of a number of these Lakelets. For the following interesting results, which are entirely trustworthy, the Survey is indebted to the kindness of Mr. Underwood:—

"*Como Lake* (1475′ A. T.) at village of Lake Como, depth 24′, has two considerable inlets; outlet into Equinunk waters.

Upper Twin ½ mile north of Como. No inlet; outlet into Lower Twin; depth 68′.

Lower Twin, ¼ mile S.E. of Upper Twin; outlet into Equinunk; depth 62′.

Eastern Spruce, one mile south of Como; no inlet; outlet into Como; smallest one sounded; area 30 to 35 acres; marshy on side next to Como Lake with large swamp extending to within ¼ mile of the latter.

Sly, ¼ mile S.E. of Spruce; no inlet; outlet into Equinunk; depth 59′; area 60 to 70 acres.

Long, 1½ miles S.SW. from Como; no inlet; outlet into Equinunk; depth 52′.

Seven Mile, one mile S.SW. from Como; one considerable inlet; outlet into Equinunk; depth 22′; area about 75 acres.

Coxtown (A. T. 1950′), 1½ miles N. W. from Preston Center; no inlet; outlet into Starrucca creek; depth 47′; area 80 to 90 acres.

Western Spruce (A. T. 1960′), ½ mile S. W. from Preston Center; small inlet; outlet into Starrucca creek; depth 21′; area about 75 acres. Both this and Coxtown have comparatively low surroundings.

I find that the most of them, the shallow ones especially, have comparatively level floors, sometimes exhibiting only a foot or two of variation in 200 or 300 yards. The water in the deeper ones is very clear, while in the shallow ones it is colored like swamp water, their bottoms consisting of soft vegetable mud to an unknown depth. I have no doubt that the filling up process now going on in them has converted many former lakes into our present swamps, and greatly reduced the size of others."

The wisdom and justness of this last remark of Mr. Underwood's, founded on intelligent observation, is sufficiently patent to any one who has studied the structure of lakelets and their surroundings.

Eighteen lakelets of considerable size are to be found in Preston, those not previously mentioned being:

Big Hickory Pond,	Preston,	1950′
Little Hickory "	"	2000′
Bone	"	2000′
Independent "	"	1950′
Pointed "	"	1975′
Five Mile "	"	1975′
Belmont Lake,	"	1950′
Chchocton Pond,	"	1775′
Beaver "	"	—

In other townships of Wayne.

		A. T.
Lizard Lake,	Buckingham,	1250′
Preston "	"	—
Dillon's "	"	—
Adam's "	"	1300′
Carr's "	"	1425′
High "	"	—
Belmont "	Mt. Pleasant,	1950′
Bigelow "	"	—
Mud Pond	"	—
Rock Lake	"	1600′
Miller's Pond	"	—
Upper Woods Pond,	Lebanon,	1500′
Lower " "	"	1450′
Duck Harbor "	"	1350′
Rose "	"	—
Niles "	"	—
Cline "	Damascus,	--
Galilee "	"	--
Swag "	"	—
Laurel Lake	"	1265′
Gorham "	"	—
Spruce "	Oregon,	—
Lovclace "	"	—

Mud Pond,	Oregon,	——
Lower Wilcox Pond,	"	——
Upper " "	"	——
Day "	"	——
Cramer "	in Dyeberry Tp.,	——
First Pond (Glass Factory)	"	1460′
Second "	"	1475′
Third "	"	——
Jenning's Pond	"	——
White Oak "	in Clinton Tp.,	1375′
Elk "	"	——
Mud "	"	——
Martwick's "	"	——
Perron's "	"	——
Stanton "	in Canaan Tp.,	1400′
Keen's "	"	1320′
Hoadley's "	"	——
Curtis's "	in S. Canaan Tp.,	——
Kizer's "	"	——
Cadjaw "	in Cherry Ridge Tp.,	1295′
Clark's "	"	1395′
Sand "	"	1350′
Bunnell's "	in Texas Tp.,	1100′
Dorflinger's "	"	1250′
Beech "	in Berlin Tp.,	1320′
William's "	"	1285′
Ridge "	in Palmyra Tp.,	1300′
Swamp Brook Pond	"	1100′
Purdy's "	in Paupack Tp.,	1350′
Long "	"	1400′
Jones' "	in Salem Tp,,	1425′
Marsh "	"	1400′
Bidwell "	"	1350′

The above list includes only the more important lakes and ponds.

In Susquehanna county, ... total, 51.
In Wayne county, ... total, 76.

Chapter III.

Surface Geology.

Drift ; buried valleys ; lake-basins ; soils.

Glacial Erosion.—Wherever the upper surfaces of hard rocks are exposed on the uplands, they are seen to be grooved and polished by the passage of the Northern Ice Sheet in the Glacial Epoch. The amount of erosion is uncertain ; but from such isolated peaks as Elk Mountain, Ararat, and Sugar Loaf—the summits of which were islands in the *Mer de Glace*, and thus escaped its action—the outlook over the surrounding country, lying from 500′ to 1000′ beneath, suggests the thought that much of it may have been removed by ice.

2200′ A. T. is the greatest elevation at which I have observed direct evidence of glaciation, either in the shape of morainic debris or striated rock surfaces. All higher summits which I have examined are destitute of *Drift deposits.*

South 20° west (mag.) is the general direction of the scratches, or striæ, on the hard Catskill sand-rocks.* There are exceptions to this course, however, where the ice current appears to have been deflected locally.

The Northern Drift.—Deposits of morainic debris are found all along the streams ; cover much of the highlands, and remain on many of the hill slopes where the latter are not so steep as to have shed them subsequently.

The material is heterogeneous ; consisting usually of both rounded and angular bowlders of *sandstone*, of *shale*, of *limestone*, and of the peculiar *calcareous breccias* of the *Catskill ;* and intermixed with all these we often find a large amount of *clay*.

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*This direction is in marked contrast to that of the *striæ* at the western line of the State (see Q^2 Q^3 Q^4) where the glacial grooves generally tend S 20° E.

Bowlders of *metamorphic rocks* are found only in the extreme northwest corner of Susquehanna county. Everywhere else the Drift-materials are derived from the rocks of the neighborhood, or from outcrops in southern New York.

Granite and *gneissoid bowlders* are confined to Apolacon, Choconut, Middletown and Rush townships of Susquehanna county; are always rounded and polished; but are of diminutive size compared with the same class of bowlders in the western part of the state. All that I noticed were less than two feet in diameter. In Beaver, Lawrence and Mercer counties it is a common thing to find them 8′ to 10′ diameter.

This inferiority in the size of Susquehanna county bowlders may indicate greater distance from the source; or more probably a less massive condition of the mother rocks of a totally different original locality.*

Salt Lick creek moraine:—Good exposures of *Drift* are infrequent. One of the best is about two miles north from New Milford, in Susquehanna Co. along the valley of Salt Lick creek. Here a great dam of morainic dèbris was thrown across the valley by the retreating ice, and piled up 100′ to 150′ above its level. The creek subsequently recut a channel through the dam around the eastern portion of the mass, leaving a great heap of the material west from the present stream, and a small portion east of it.

The section of this Drift heap, 90′ high, made by the Delaware, Lackawanna & Western railroad gravel quarry on the east bank of the stream, exposes a perfect mass of *sandstone bowlders* mostly *Catskill*, *Chemung* and *Portage* from 1″ to

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*The limitation of northern bowlders to a small area in the four townships cited above calls for some special explanation, quite apart from that of the general covering of Local Drift spread over the rest of the region. It looks as if they were dropped from the left (S. E.) flank of a great glacier on its way southwestward across Bradford county.

The glacier seems to have split against the butress of the Catskill mountains; one arm descending the Hudson valley to overflow New Jersey; the other arm slanting off S. 20° to 30° W., and flowing down the valleys of the Upper Delaware and Susquehanna rivers in New York into Bradford, Tioga, and Potter counties in Pennsylvania, where it has left the long moraine of Big Meadows at the Third Fork of Pine creek, and many other traces.

1′ in diameter, nearly all water-worn into a rudely spherical shape, and imbedded in a matrix of coarse sand and fine gravel. A few small bowlders of *limestone* looking like *Lower Helderburg* have probably come from the valley of the Mohawk, the nearest place of outcrop. I could find no *conglomerate* nor *crystalline* rocks.

Terraces and mounds:—The wide valley of the Susquehanna is filled with *Drift* trash, generally occurring in broad level terraces, but occasionally in huge conical mounds.

Opposite Susquehanna Depot on the north bank of the river some long sharp ridges 40′ to 50′ high, run parallel to the general course of the river.

Many angular fragments of local rock are seen in the *Drift* above Lanesboro, 3 miles from Susquehanna Depot.

Clay in considerable quantity is often mixed with the rock fragments of the *Drift*. This is well shown in the Ararat Summit cut on the Jefferson Branch railroad (2023′ A. T.) Here about 35′ of genuine Drift is seen and no bottom reached.

Pure clay deposits occur in places, caused in some manner by the ice.

Two miles above the mouth of Starrucca creek, is a dam of pure clay 75 feet high extending entirely across the ancient channel of the stream, which has been compelled to cut around it through the solid rock on its west bank. This clay bank is extensively worked for brick making. In the 50′ of vertical thickness exposed not a single pebble or bowlder is to be seen. The clay is of a grayish-drab color with a slight reddish tinge.

Bowlders of Catskill calcareous breccia, of immense size, are very common in the Drift both along the streams and over the uplands south from the east and west divide. Along the valley of Martin's creek they are of frequent occurrence. Over the uplands of Wayne they are often seen in immense numbers, 3′ to 6′ in diameter, generally rounded, though always roughened by weathering.

Drift deposits fill the valleys of the Lackawaxen creek and its tributaries, causing the very gentle fall in the Dyeberry between Honesdale and Tanner's Falls.

The valley of Wallenpaupack between Wilsonville and Ledgedale is one vast Drift heap over which the stream meanders for 12 miles with a scarcely preceptible fall. At Wilsonville it cuts down to the rock bottom and then descends about 250′ in a succession of great cascades in a short distance.

Buried Valleys are found to some extent in this district, though from lack of well borings we have no means of determining their depths.

The Susquehanna river flows on a bed of trash of unknown depth. I find no data that would throw light on the subject. The bed rock is sometimes seen along its course, as near Great Bend, but affords no positive evidence against a buried channel ; for the rock is only seen when the stream veers away from the central line of the valley and washes one of its bounding hill-sloops. The aspect of the Drift suggests an ancient buried water-way of considerable depth.

The Delaware river channel, on the contrary was never deeper than it is at present, for a rock bottom is frequently seen extending clear across its channel, the hills rising almost perpendicularly from its banks.

The Lackawaxen and its principal tributaries all flow over buried channels of considerable depth, if one may depend on the surface indications.

In Susquehanna county there are two or three instances in which streams are now flowing in opposite directions, with their heads at a very low divide in the floor of probable ancient waterways.

One of these is the old valley in which Martins creek flows southward, and Salt Lick creek northward. The divide between the two streams is a low Drift deposit in a comparatively narrow valley 500′ below the general level of the uplands. It looks as if a stream had once flowed northward through this ancient channel from a point much further south than the present divide, and a dam of Drift had been thrown across it at the present summit (1175′ A. T.) reversing the direction of the upper part of the stream, and sending it southward to the Susquehanna, by way of Tunkhannock creek.

At the heads of Choconut and Apolacon creeks similar low Drift-filled divides are seen separating their waters from those that go southward into the Wyalusing.

The Soils of the region.

The soils of the district have been largely derived from the decomposition of rocks *in situ*, since the hill slopes are generally so steep that the Drift is seldom found remaining on them except in scattered patches.

Since the *Catskill system* furnishes almost all of the surface rocks in this district, the soils have been largely derived either from their gradual decay or trituration by glacial action.

The *red shales* of the *Catskill* have probably contributed more to the formation of the soil than any other part of it, and it is the universal testimony of the farmers that the "*red shale soils*" are generally stronger and richer than any others.

A sample of the *Catskill red shale* which forms the basis for so much soil in the district was forwarded to the laboratory of the survey at Harrisburg and analyzed by Mr. Stinson with the following result:

Silica,	59.260	
Alumina,	19.877	(by deduction.)
Sesquioxide of iron,	10.071	
Lime,	0.250	
Magnesia,	1.917	
Sulphuric acid,	0.012	
Phosphoric acid,	0.158	
Water,	3.600	
Alkalies,	4.855	

The amount of alkalies in the shale doubtless accounts for the fertility of its soil, since the quantity of lime and phosphoric acid is not sufficient to have any marked influence for good.

But while the *red shale soils* are usually the best in the district it is equally true that only in isolated patches and in favorable localities do we find any really first class soils within the district. The great body of the surface is covered by a thin sandy soil of very little natural fertility, and except in the vicinity of swamps, where a great thickness of decayed vegetable material has accumulated, and along some of the larger streams like the Susquehanna, where the Drift deposits are extensive, there is not much land within the district that will produce abundant crops until it has been fertilized artificially. The hill slopes are moreover steep and the surface generally rugged. Excellent crops of grass grow on almost any of the soils, and grazing is the chief employment with the more intelligent.

Lime bowlders; niggerheads.—The great need of the soils is lime, and the more sandy soils are furnishing it. There are no pure limestone strata in the *Catskill series*, but there are a great many layers of *impure calcareous* conglomerate or *breccia* interstratified with the shales and sandstone of this series. Huge fragments of this kind of rock lie scattered about over a large portion of the district, blackened by exposure to the air.

These "Nigger-heads" contain from 10 to 65 per cent of lime, and might often be burned to great advantage for lime manure. Many of the farmers have noticed the fact that the grass grows greener and richer near them, their lime being dissolved out by every shower to enrich the surrounding soil. But very few farmers have the least idea that these rocks contain enough lime to be of any service for burning. Mr. Schenk of Cherry Ridge is perhaps the only resident of the district who has tried a kiln, and he reports that the good effect upon his crops has been more marked than when he used the best stable manure.

These bowlders are so thickly strewn over some portions of Wayne county as to be a serious nuisance. Two birds could be killed with one stone—the land cleaned and the soil manured—by breaking up and burning them into lime. Even those of them least rich in lime might be turned to account, if farmers in clearing their lands would only build and burn their log-heaps over and around these rocks. By this means they would get such a roasting that the smaller ones would slack down, while a large coating of lime would fall away from the larger ones after every such operation.

When they are burned regularly in a kiln considerable care must be exercised in selecting the purer bowlders; for many of them possess only just enough lime to flux the silicious material in the stone, and choke up the kiln with a slag, which on cooling becomes a solid mass with which nothing can be done.

The Flora of the Region.

A great variety of trees and herbaceous vegetation grows in the district. The principal forest trees however are conifers, and so abundant is the Hemlock Spruce (*Abies Canadensis*) that it has given rise to a very important industry in both counties, viz: the manufacture of leather. Wayne and Susquehanna counties have long been noted for the value and extent of their leather production. There are about twenty extensive tanneries in Wayne and about half as many in Susquehanna, the annual product of which amounts to several millions of dollars. These once extensive forests of Hemlock are now however fast disappearing under the constant destruction for bark, so that within the past year two or three extensive tanneries in Wayne have been compelled to suspend operations on this account.

At my request, Prof. Jno. M. Dolph, an accomplished botanist of Honesdale, prepared a list of the plants which he has observed in Wayne county during the last two years. The list is of course imperfect since many portions of the county have not been visited, yet as it includes the plants of general distribution, it may be taken as a very fair representation of the Flora of the district. The following list and accompanying letter give the results of Prof. Dolph's work on this subject:

HONESDALE, PA., *February 24, 1881.*

Prof. I. C. WHITE:

DEAR SIR: In accordance with your request I send you herewith, a list of the plants of Wayne county, Pa., which I have personally examined and identified.

That it is far from being a complete Flora, I have no doubt, as I have not visited all sections of the county and have, as yet, made but slight investigation in the direction of several families of plants.

Very truly yours,
JOHN M. DOLPH.

Clematis Viorna, L.
“ *Virginiana*, L.
Anemone Virginiana, L.
“ *Pennsylvanica*, L.
“ *nemorosa*, L.
Hepatica triloba, Chaix.
“ *acutiloba*, D'C.
Thalictrum anemonoides, Michx.
“ *Cornuti*, L.
Ranunculus, *aquatilis*, L., var.
tricophyllus, Chaix.
“ *multifidus*, Pursh.
“ *abortivus*, L.
“ *recurvatus*, Poir.
“ *Pennsylvanicus*, L.
“ *acris*, L,
“ *repens*, L.
Caltha palustris, L.
Coptis trifolia, Salisb.
Aquilegia Canadensis, L.
Actea spicata, L., var. *rubra*, Michx.
“ *alba*, Bigel.
Magnolia acuminata, L.
Liriodendron Tulipifera, L.
Podophyllum peltatum, L.
Nymphaea odorata, Ait.
Nuphar advena, Ait.
Sarracenia purpurea, L.
Stylophorum diphyllum, Nutt.
Sanguinaria Canadensis, L.
Adlumia cirrhosa, Raf.
Dicentra Cucularia, D'C.
“ *Canadensis*, D'C.
“ *eximia*. D'C.
Corydalis glauca, Pursh.
Nasturtium palustre, D'C.
“ *Armoracia*, Fries.
Cardamine rhomboidea, D'C.
Brassica (*Sinapis*) *alba*, L.
“ *nigra*, L.
“ *arvensis*, L.
Capsella Bursa-pastoris, Moench.
Lepidium Virginicum, L.
Solea concolor, Ging.
Viola rotundifolia, Michx.
“ *lanceolata*, L.

Campanula rotundifolia, L.
“ *rapunculoides*, L.
Gaylussacia frondosa, Torr. & Gray.
“ *resinosa*, Torr. & Gray.
Vaccinium Oxycoccus, L.
“ *Pennsylvanicum*, Lam.
“ *macrocarpon*, Ait.
“ *vacillans*, Solander.
“ *corymbosum*, L.
Arctostaphylos Uva-Ursi, Spreng.
Epigaea repens, L.
Gaultheria procumbens, L.
Kalmia latifolia, L.
“ *angustifolia*, L.
“ *glauca*, Ait.
Azalea arborescens, Pursh.
“ *viscosa*, L.
“ *nudiflora*, L.
Rhododendron maximum, L.
Pyrola elliptica, Nutt.
Chimaphila umbellata, Nutt.
Monotropa uniflora, L.
Plantago major, L.
“ *lanceolata*, L.
Trientalis Americana, Pursh.
Lysimachia stricta, Ait.
“ *quadrifolia*, L.
“ *ciliata*, L.
Lysimachia lanceolata, Walt.
“ *nummularia*, L.
Verbascum Thapsus, L.
Linaria vulgaris, Mill.
Scrophularia nodosa, L.
Chelone glabra, L.
Mimulus ringens, L.
“ *alatus*, Ait.
Ilysanthus gratioloides, Benth.
Veronica scutellata, L.
“ *officinalis*, L.
“ *alpina*, L.
“ *serpyllifolia*, L.
Gerardia flava, L.
“ *integrifolia*, Gray.
Castilleia coccinea, Spreng.
Verbena hastata, L.
“ *urticifolia*, L.

Viola blanda, Willd.
" *pubescens*, Ait.
" *cuculata*, Ait.
" *sagittata*, Ait.
" *canina*, L., var. *sglvestris*, Regel.
" *rostrata*, Pursh, var. *corniculata*, N. var.
" *striata*, Ait.
" *Canadensis*, L.
" *tricolor*, L.,var. *arvensis*, Gray.
Hypericum ellipticum, Hook.
" *perforatum*, L
Elodes Virginica, Nutt.
Saponaria officinalis, L.
Silene noctiflora, L.
Lychnis Githago, Lam.
" *coronaria*, D'C.
Arenaria serpyllifolia, L.
Stellaria media, Smith.
" *pubera*, Michx.
" *longifolia*, Muhl.
Cerastium viscosum, L.
" *nutans*, Raf.
" *arvense*, L.
Scleranthus annuus, L.
Portulaca oleracea, L.
Claytonia Virginica, L.
" *Caroliniana*, Michx.
Malva rotundifolia, L.
" *moschata*, L.
Tilia Americana, L.
" *heterophylla*, Vent.
Geranium maculatum, L.
" *Robertianum*, L.
Impatiens pallida, Nutt.
" *fulva*, Nutt.
Oxalis stricta, L.
Zanthoxylum Americanum, Mill.
Ptelea trifoliata, L.
Rhus typhina, L.
" *glabra*, L.
" *copallina*, L.
" *Toxicodendron*, L.
" *venenata*, D'C.
Vitis Labrusca, L.
" *aestivalis*, Michx.
" *cordifolia*, Michx.
Ampelopsis quinquefolia, Michx.
Celastrus scandens, L.
Euonymus atropurpureus, Jacq.
Acer dasycarpum, Ehrh.
Trichostema dichotomum, L.
Mentha rotundifolia, L.
" *viridis*, L.
" *piperita*, L.
" " var. *subhirsuta*, Benth.
" *Canadensis*, L.
Lycopus Virginicus, L.
" *Europaeus*, L., var. *sinutus*, Gray.
Pycnanthemum incanum, Michx.
Calamintha Clinopodum, Benth.
Hedeoma pulegioides, Pers.
Collinsonia Canadensis, L.
Monarda didyma, L.
Nepeta Cataria, L.
" *Glechoma*, Benth.
Brunella vulgaris, L.
Scutellaria canescens, Nutt.
" *galericulata*, L.
" *lateriflora*, L.
Galeopsis Tetrahit, L.
Stachys palustris, L.
Leonurus Cardiaca, L.
Lamium album, L.
Echium vulgare, L.
Myosotis palustris, Withering.
Cynoglossum officinale, L.
" *Morisoni*, D'C.
Phlox subulata, L.
Phlox paniculata, L.
Ipomoea purpurea, Lam.
" *lacunosa*, L.
Convolvulus arvensis, L.
Cuscuta Gronovii, Willd.
" *rostrata*, Shuttleworth.
Solanum Dulcamara, L.
Physalis Philadelphica, Lam.
Lycium vulgare, Dunal.
Gentiana crinita, Froel.
" *Andrewsii*, Griseb.
Apocynum androsaemifolium, L.
Asclepias Cornuti, Decaisue.
" *purpurascens*, L.
" *incarnata*, L.
Chionanthus Virginica, L.
Fraxinus Americana, L.
" *sambucifolia*, Lam.
Phytolacca Decandra, L.
Chenopodium album, L.
" *hybridum*, L.
" *Botrys*, L.

Acer Pennsylvanicum, L.
“ *spicatum*, Lam.
“ *saccharinum*, Wang.
“ “ var. *nigrum*, Gray.
“ *rubrum*, L.
Negundo aceroides, Moench.
Lupinus perennis, L.
Trifolium arvense, L.
“ *pratense*, L.
“ *repens*, L.
“ *agrarium*, L.
“ *procumbens*, L.
Melilotus alba, Lam.
Robinia Pseudacacea, L.
Desmodium paniculatum, D'C.
Lespedeza violacea, *Pers.*
“ *hirta*, Ell.
Phaseolus perennis, Walt.
Amphicarpæa monoica, Nutt.
Lathyrus palustris, L.
Prunus Americana, Marshall.
“ *Pennsylvanica*, L.
“ *Virginiana*, L.
“ *serotina*, Ehrh.
Spirea salicifolia, *L.*
“ *tomentosa*, L.
Agrimonia Eupatoria, L.
Waldsteinia fragarioides, Tratt.
Potentilla Norvegica, L.
“ *Canadensis*, L.
“ “ var. *simplex*, Torr & Gray.
“ *palustris*, Scop.
Fragaria Virginiana, Ehrh.
“ *vesca*, L.
Rubus odoratus, L.
“ *strigosus*, Michx.
“ *occidentalis*, L.
“ *villosus*, Ait.
“ *Canadensis*, L.
“ *hispidus*, L.
“ *cuneifolius*, Pursh.
Rosa Carolina, L.
“ *lucida*, Ehrh.
Crategus coccinea, L.
“ *Crus-galli*, L.
“ *tomentosa*, L.
Pyrus coronaria, L.
“ *Americana*, D'C.
Amelanchier Canadensis, Torr. & Gray.
Ribes Cynosbati, L.

Amaranthus hyppochondriacus, L.
“ *retroflexus*, L.
“ *albus*, L.
Polygonum Pennsylvanicum, L.
“ *incarnatum*, Ell.
“ *Persicaria*, L.
“ *Hydropiper*, L.
“ *acre*, H. B. K.
“ *Virginianum*, L.
“ *aviculare*, L.
“ “ var. *erectum*, Roth.
“ *sagittatum*, L.
“ *Convolvulus*, L.
Polygononum dumetorum, L.
“ “ var. *scandens*, Gray.
Rumex orbiculatus, Gray.
“ *crispus*, L.
Rumex obtusifolius, L.
“ *sanguineus*, L.
“ *Acetosella*, L.
Sassafras officinale, Nees.
Lindera Benzoin, Meisner.
Euphorbia maculata, L.
“ *corollata*, L.
Ulmus fulva, Michx.
“ *Americana*, L.
“ *racemosa*, Thomas.
Morus rubra, L.
Urtica gracilis, Ait.
“ *dioica*, L.
Pilea permila, Gray.
Boehmeria cylindrica, Willd.
Humulus Lupulus, L.
Plantanus occidentalis, *L.*
Juglans cinerea, L.
“ *nigra*, L.
Carya alba, Nutt.
“ *tomentosa*, Nutt.
“ *porcina*, Nutt.
“ *amara*, Nutt.
Quercus alba, L.
“ *bicolor*, Willd.
“ *nigra*, L.
“ *Muhlenbergii*, Engelm.
“ *prinoides*, Willd.
“ *tinctoria*, Bartram.
“ *rubra*, L.
Castanea vesca, L,
Fagus ferruginea, Ait.
Corylus Americana, Walt.

Ribes lacustre, Poir.
“ *floridum*, L.
“ *rubrum*, L.
Saxifraga Virginiensis, Michx.
Mitella diphylla, L.
Tiarella cordifolia, L.
Penthorum sedoides, L.
Sedum acre, L.
“ *ternatum*, Michx.
“ *Telephium*, L.
Hamamelis Virginica, L.
Hippuris vulgaris, L.
Circea Lutetiana, L.
Epilobium angustifolium, L.
“ *coloratum*, Muhl.
Œnothera biennis, L.
“ *linearis*, Michx.
“ *pumila*, L.
Ludwigia palustris, Ell.
Lythrum Salicaria, L.
Sicyos angulatus, L.
Daucus Carota, L.
Hydrocotyle Americana, L.
Sium lineare, Michx.
Osmorrhiza brevistylus, D'C.
Aralia spinosa, L.
“ *racemosa*, L.
“ *nudicaulis*, L.
“ *quinquefolia*, Gray.
Cornus Canadensis, L.
“ *florida*, L.
“ *stolonifera*, Michx.
“ *paniculata*, L'Her.
Nyssa multiflora, Wang.
Lonicera flava, Sims.
“ *ciliata*, Muhl.
Diervilla trifida, Moench,
Sambucus Canadensis, L.
“ *pubens*, Michx.
Viburnum Lentago, L.
“ *prunifolium*, L.
“ *nudum*, L.
“ *dentatum*, L.
“ *pubescens*, Pursh.
“ *acerifolium*, L.
“ *lantanoides*, Michx.
Galium Aparine, L.
“ *asprellum*, Michx.
“ *trifidum*, L.
Galium pilsosum, Ait.
Mitchella repens, L.
Houstonia caerulea, L.
Corylus rostrata, Ait.
Ostrya Virginica, Willd.
Carpinus Americana, Michx.
Comptonia asplenifolia, Ait.
Betula lenta, L.
“ *lutea*, Michx.
“ *nigra*, L.
“ *papyracea*, Ait.
Alnus incana, Willd.
“ *serrulata*, Ait.
Salix sericea, Marshall.
“ *cordata*, Muhl.
“ *alba*, L.
Populus tremuloides, Michx.
“ *heterophylla*, L.
“ *grandidentata*, Michx.
“ *balsamifera*, L. var . *candicans*, Gray.
Pinus rigida, Miller.
“ *inops*, Ait.
“ *mitis*, Michx.
“ *resinosa*, Ait.
“ *Strobus*, L.
Abies Canadensis, Michx.
“ *balsamea*, Marshall.
“ *Fraseri*, Pursh.
“ *Alba*, Michx.
Larix Americana, Michx.
Taxus baccata, L., var. *Canadensis*, Gray.
Arisaema triphyllum, Torr.
Symplocarpus foetidus, Salisb.
Acorus Calamus, L.
Typha latifolia, L.
“ *angustifolia*, L.
Alisma Plantago, L. var. *Americanum*, Gray.
Echinodorus parvulus, Engelm.
Sagittaria variabilis, Engelm.
Orchis spectabilis, L.
Habenaria orbiculata, Torr.
“ *psycodes*, Gray.
“ *fimbriata*, R. Br.
Spiranthes graminea, Lindl.,var. *Walteri*, Gray.
Cypripedium candidum, Muhl.
“ *pubescens*, Willd.
“ *spectabile*, Swartz.
Iris versicolor, L.
“ *Virginica*, L.
Sisyrinchium Bermudiana, L.
Smilax hispida, Muhl.

Dipsacus sylvestris, Mill.
Vernonia Noveboracensis, Will.
Eupatorium purpureum, L.
" *hyssopifolium*, L.
" *perfoliatum*, L.
" *ageratoides*, L.
Aster corymbosus, Ait.
" *macrophyllus*, L.
" *patens*, Ait.
" *laevis*, Ait.
" *undulatus*, L.
" *cordifolius*, L.
" *sagittifolius*, Willd.
" *simplex*, Willd.
" *tenuifolius*, L.
" *puniceus*, L.
" *prenanthoides*, Muhl.
" *acuminatus*, Michx.
Erigeron Canadense, L.
" *annuum*, Pers.
Solidago bicolor, L.
" *latifolia*, L.
" *puberula*, Nutt.
" *speciosa*, Nutt.
" *Muhlenbergii*, Torr. & Gray.
" *altissima*, L.
" *pilosa*, Walt.
" *nemoralis*, Ait.
" *Canadensis*, L.
" *odora*, Ait.
" *gigantea*, Ait.
" *lanceolata*, L.
Inula Helenium, L.
Ambrosia trifida, L.
" *artemisiaefolia*, L.
Xanthium strumarium, L.
" var. *echinatum*, Gray.
Heliopsis laevis, Pers.
Rudbeckia laciniata, L.
" *triloba*, L.
" *hirta*, L.
Helianthus annuus, L.
" *divaricatus*, L.
" *tracheliifolius*, Willd.
" *doronicoides*, Lam.
Bidens frondosa, L.
" *connata*, Muhl.
" *cernua*, L.
Maruta Cotula, D'C.
Anthemis arvensis, K.
" *nobilis*, L.
Achillea Millefolium, L.
Trillium erectum, L.
" " var. *album*, Pursh.
" *cernuum*, L.
" *erythrocarpum*, Michx.
Veratrum viride, Ait.
Uvularia perfoliata, L.
" *sessilifolia*, L.
Streptopus roseus, Michx.
Smilacina racemosa, Desf.
" *bifolia*, Ker.
Polygonatum biflorum, Ell.
Lilium Philadelphicum, L.
" *Canadense*, L.
Erythronium Americanum, Smith.
Juncus effusus, L.
" *tenuis*, Willd.
" *nodosus*, *L.*
Cyperus diandrus, Torr.
" *phymatoides*, Muhl.
" *strigosus*. L.
Scirpus pungens, Vahl.
" *lacustris*, L.
" *sylvaticus*, L.
Carex flava, L.
" *vulpinoidea*, Michx.
" *squarrosa*, L.
" *hystricina*, Willd.
" *tentaculata*, Muhl.
Eriophorum gracile, Koch.
Alopecurus pratensis, L.
" *geniculatus*, L.
" *aristulatus*, Michx.
Phleum pratense, L.
Agrostis scabra, Willd.
" *vulgaris*, With.
Calamagrostis Canadensis, Beauv.
Cynodon Dactylon, Pers.
Eleusine Indica, Gaertn.
Tricuspis sesleroides, Torr.
Dactylis glomerata, L.
Glyceria Canadensis, Trin.
Poa Annua, L.
" *compressa*, L.
" *serotina*, Ehrh.
" *pratensis*, L.
Briza Media, L.
Bromus secalinus, L.
Uniola latifolia, Michx.
Triticum repens, L.
Anthoxanthum odoratum, L.
Phalaris Canariensis, L.
Panicum sanguinale, L.

Lucanthemum vulgare, Lam.
Tanacetum vulgare, L.
Artemisia Absinthium, L.
Gnaphalium decurrens, Ives.
Antennaria margaritacea, A. Brown.
" *plantaginifolia*, Hook.
Erechthites hieracifolia, Raf.
Cirsium lanceolatum, Scop.
" *altissimum*, Spreng.
" *pumilum*, Spreng.
" *arvense*, Scop.,
" " var. *album*.
Lappa officinalis, Allioni.
Hieracium scabrum, Michx.
" *venosum*, L.
" *paniculatum*. L.
Nabalus albus, Hook.
" *altissimus*, Hook.
" *Fraseri*, D'C.
Taraxacum Dens-leonis, Desf.
Lactuca, Canadensis, L.
" *integrifolia*, Torr. & Gray.
" *sanguinea*, Torr. & Gray.
Mulgedium leucophaeum, D'C.
Sonchus asper, Vill.
Lobelia cardinalis, L.
" *syphilitica*, L.
" *inflata*, L.
Panieum capillare, L.
" *virgatum*, L.
" *Crus-galli*, L.
Setaria glanca, Beauv.
" *viridis*, Beauv.
Sorghum nutans, Gray.
Equisetum arvense, L.
" *hyemale*, L.
Polypodium vulgare, L.
Adiantum pedatum, L.
Pteris aquilina, L.
Woodwardia Virginica, Smith.
Asplenium Trichomanes, L.
" *angustifolium*, Michx.
Camptosorus rhizophyllus, Link.
Aspidium Noveboracensis, Swartz.
" *spinulosum*, Swartz.
" *marginale*, Swartz.
" *acrostichoides*, Swartz.
Onoclea sensibilis, L.
Osmunda regalis, L.
Lycopodium dendroideum, Michx.
" *clavatum*, L.
Selaginella rupestris, Spreng.

CHAPTER IV.

The Geology of the Region.

1. *The rock formations* all belong to the series of formations which underlie the true or Productive Coal Measures.

There are no true Coal Measures in the two counties.

The Third Anthracite Coal Field comes nearly up to, but does not quite reach the county line—so far as its lowest workable beds are concerned,—but the basin itself runs on northward. Its bounding mountain walls of *Pottsville Conglomerate* unite and form the high northern end or prow of the Canoe.

The Pottsville Conglomerate, however, has coal beds lying between its massive sandrock strata ; and these, the only deposits of coal in the two counties which deserve notice, will be described in Chapter V.

The Pottsville Conglomerate rocks (No. XII) occupy a narrow pointed triangular area of only about one square mile in the southeast corner of Susquehanna county, and in the neighboring border of Wayne.

The Mauch Chunk red-shales (No. XI) underlying the Conglomerate, rise to the surface on the east and west of the triangle, and continue in a narrow pointed belt to the north of it along the county line. The dips on the two sides of the trough vary between 8° and 30°; and the breadth of outcrop is slight, because the whole formation (3000′ thick at Mauch Chunk) is here less than 200′ thick, as described in Chapter V.

The Pocono Sandstone formation (No. X) being 600′ or 700′ thick, and dipping 10° or 12°, crop out along two somewhat broader belts, one in Susquehanna county (a continuation of the Lackawanna mountain); the other in Wayne county a (continuation of the Moosic mountain,) outside the narrow belts of shale. The two outcrops unite and continue as one, northward, along and a little west of the county line.

The Catskill formation (No. IX), measuring from top to bottom about 2000′, spreads itself almost horizontally over the rest of the surface of the two counties, 95 per cent. of which is occupied by the faces and edges of sandstone, shale, and calcareous breccia beds belonging to this formation. Almost all the valleys are excavated in it, and their side slopes are cliffed and terraced by its nearly horizontal strata. But none of these valleys are deep enough to reach and expose the underlying *Chemung.*

Chemung rocks (No. VIII) are exposed only in Northern Susquehanna county, along the wide valley of the Susquehanna river, and the narrower valleys of the streams flowing into it; and in the northwest corner of the county the *Towanda anticlinal* elevates the *Chemung* to the hilltops, so that 275′ feet of the upper part of the formation is exposed.

The total column of strata (XII, XI, X, IX and VIII) visible at various parts of the surface of the region amounts to about 3355′.

2. *The rock structure* of the region is somewhat anomalous and very interesting.

The most striking feature of the geological map accompanying this report is the very curious curling up of the end of the Carbondale coal basin, northward; and the continuation of the axis of its trough (or synclinal) in a nearly due north direction along the mid-county line.

This is a remarkable violation of the general law of direction which governs the whole system of anticlinals and synclinals in Pennsylvania; virtually cutting off those of the Alleghany mountain region, as represented in section along the Susquehanna river, on the west, from all connection with those of the Catskill mountain region of New York State, as represented in cross section along the Delaware river.

The cause of this phenomenon is concealed.

Its effects are manifested in Susquehanna county by the dying down or flattening out eastward, or northeastward, of all the great parallel troughs and arches described in the reports on Sullivan, Lycoming, Bradford and Tioga counties; also, in the dying away or flattening out of the New York troughs and arches, westward, as they enter and pass on through Wayne county.

Consequently no one of the Susquehanna river folds can be identified with any of the Delaware river folds—the two systems of folds flattening out as they approach each other and being kept apart by the north and south fold which cuts transversely across and between them.

The Lackawanna Coal Basin is the northern horn of the crescent-shaped Third Anthracite Coal Field, the distant western horn of which ends at Schickshinny Knob in Montour county. The axis of the basin runs from Wilkesbarre to Scranton, about N. 50° E.; from Scranton to Carbondale about N. 30° E.; from Carbondale to the Susquehanna county corner about N. 15° E.; and thence onward about N. 5 E. along the western edge of Wayne county.

The rocks of Lackawanna (Schickshinny) mountain, on the northwest dip southeast under the coal measures of the basin.

The rocks of the Moosic (Wyoming) mountain, on the southeast, dip northwest under the coal measures of the basin.

These two dips make the trough of the synclinal. But the trough rises and comes to a pointed end, and the two dips flatten to almost a horizontal, on the top of the Moosic mountain, where it joins the Lackawanna mountain and forms with it a sort of elevated table land in Clinton and Mount Pleasant townships of Wayne County.

This table land sweeps around the east and southeast border of the coal basin through Canaan, South Canaan, and Salem townships, and makes the high table land (in Lackawanna county,) drained by the eastern waters of the Lehigh river, the great Beech Woods country, formerly called the Shades of Death. Its southeast edge is the escarpment of the Pocono montain in Pike and Monroe county. Its rocks are almost horizontal, but have a very gentle slope from the Pocono escarpment northwestward towards Wilkesbarre and Scranton.

But the slope throughout Wayne County as a whole is southward; and this accounts for the great water-tree of the Lackawaxen creek from Belmont lake in Preston, past Honesdale, southward to the Paupack Falls, at the extreme southern corner of Wayne county.

The slope of the rocks however is so nearly horizontal that it may be estimated throughout Wayne county, north of Honesdale, at from 20′ to 30′ per mile. South of Honesdale the rocks seem to be absolutely horizontal. Occasionally there is an appearance even of a slight southward rise.

No well defined general rolls, anticlinal or synclinal, can be followed across Wayne county anywhere. Local rolls, and reversed dips exist, but they are so slight and insignificant that they cannot be laid down on a geological map.

The whole of Wayne county may therefore be looked upon as an almost horizontal inclined plane, of Catskill measures, down which flow the Delaware and the numerous branches of the Laxawaxen creek, southward, into Pike county.

On the western edge of this nearly horizontal Catskill outspread of Wayne county a slight synclinal trough develops itself in Preston and Mt. Pleasant counties, in which patches and ridges of *Pocono Sandstone* have been preserved. As this trough deepens southward the *Mauch Chunk shales* come in, and then the *Pottsville Conglomerate.* Deepening now more rapidly as it approaches Carbondale, it begins to hold the lowest coal beds and finally becomes the deep, complicated Scranton, Pittston and Wilkesbarre coal basin.

The descent of the *Pocono Sandstone* beds, in its eastern wall, Moosic mountain, (in Clinton township, Wayne county) is at the rate of 8° to 10°.

West of the Lackawanna mountain the dip becomes gentle and finally (in four or five miles from the center line of the basin) horizontal. Then the rocks roll over and dip gently northwestward towards the Tunkhannock. This roll is on the line of one of the greatest of all the anticlinals of Pennsylvania. Starting from the southeast corner of Susquehanna county and running in a grand gentle curve through Greenfield, Abingdon, and Newton townships (Lackawanna county,) it crosses the Susquehanna river 7 miles above Pittston; passes near Lehman and Harveyville in Luzerne county; Rohrsburg in Columbia county; Whitehall in Montour county; Watsonburg in Northumberland county; elevates the White Deer mountain in Union county; and finally brings up Lower Silurian rocks in Sugar Valley (Clinton county,) in Middle Pennsylvania.

It is the grand geological divide between the Third Anthracite Coal Field on the south and the Alleghany mountain coal fields to the north.

The south and southeast dips of this anticlinal, in its western and middle course, become east dips at its eastern end, where it curves up through Clifford, Herrick and Ararat townships in Susquehanna county; and these east dips although gentle can be seen along the upper course of the Lackawanna creek.

As the escarpment of the North or Allegheny mountain represents the north and northwest dips of this anticlinal in Wyoming county, so when these become west dips, they are represented in the outlying *Pocono Sandstone* peaks of the Elk mountains in Gibson, Herrick and Clifford townships in Susquehanna county.

The resolution of some structural difficulties will probably follow the study of Lackawanna county. Until then it is safe to speak of the great anticlinal (of White Deer mountain) as virtually dying out in Herrick township between the Elk mountains and the Lackawanna mountain.

Although the Elk mountains are isolated, yet they seem to be only a part the great range of the high lands which border Tunkhannock creek and extend northwards between Jackson and Thompson townships.

The Wilmot Anticlinal described in the report on Bradford county (G) ranges from the southwest corner of Susquehanna county northeastward into New Milford township, where its gentle northwest dips cover a breadth of two and a half miles. Its south dips are so exceedingly gentle that they may be estimated at less than 1°, viz: at from 50′ to 75′ per mile. So that in all the southern part of the county the rocks are nearly horizontal. This is the state of things west of the Elk mountains.

The Towanda anticlinal of Bradford county, if it runs on to Great Bend, is represented there by the gentle northerly dips observable along the river hills.

The Rome-Warren anticlinal of Bradford county elevates the rock strata of the northwest corner of Susquehanna county enough to make all the hills *Chemung*, none of the Catskill basal layers being preserved upon them; but the dips on each side of it could only be calculated from data got by an instrumental survey. Practically the rocks of the whole region may be considered horizontal.

Returning to the northern part of Wayne county the map shows the following peculiarities:

1. An extraordinary collection of ponds in Preston township.

2. That these ponds are drained in all directions:—north, by the Starucca; northeast by the Chehocton; east, by the Equinunk; south, by the Lackawannock; and southwest, by the Lackawanna.

3. That the summit plateau of the region occupied by these ponds is connected directly with the Moosic mountain end of the great synclinal.

There must be some *geological* cause for this knot of highland, so flat on top as to hold scores of lakes, and from which the waters drain off in all directions.

The Stockport anticlinal furnishes, probably, the required explanation.

At Stockport on the Delaware the rocks dip very gently up river; and this northwardly dip continues for miles along the river towards Port Deposit.

Below Stockton the rocks in the Delaware cliffs dip southward, also very gentle and for many miles, as has already been said.

The anticlinal roll or arch thus shown, must pass across Wayne county in a west-southwest direction, under the Preston township highland, with its ponds, towards the end of the Moosic mountain; and this anticlinal has probably caused the death of the Lackawanna coal basin, by lifting into the air the whole of Mt. Pleasant township.

This anticlinal has had two other effects:—it has forced the Chehocton and Shrawder creek waters to flow northeastward, sloping down the dip; and the whole water-tree of the Starucca creek to flow northwestward, directly down the dip;—and it has forced the two great branches of the Delaware river to unite before cutting through the anticlinal.

Shrawder's creek itself flows along a synclinal, described by Mr. Sherwood as running east-northeastward through New York State. This synclinal must pass (westward) under Starucca, and flatten out in Susquehanna county, unless it bends southward and connects itself with the Moosic mountain synclinal. But where the country is so covered with surface deposits, and its rocks so nearly horizontal that nothing short of innumerable lines of spirit level survey can determine the existence of any dip at all, such identifications become as difficult as they are unimportant.

North east end of the Lackawanna basin.

To illustrate Report G⁵ page 44

Fig 1.

Scranton Section S.E.

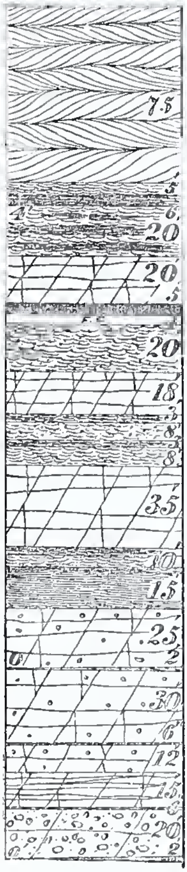
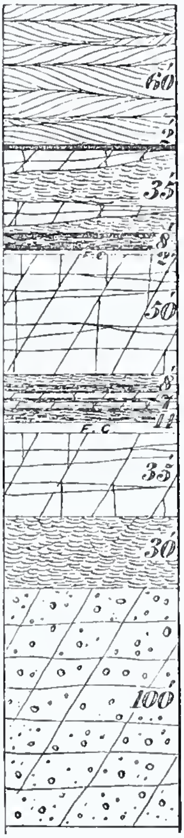


Fig. 2.

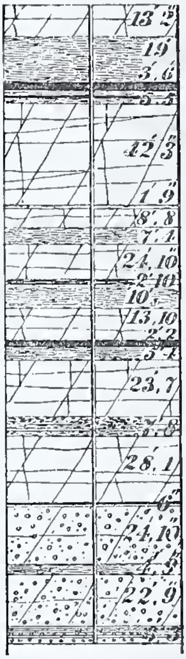
Scranton Section N.W.



Forest City Coal.

Fig. 3.

Forest City Diamond Drill hole.



CHAPTER V.

The Pottsville Conglomerate, No. XII.

As has been said, there remains a sharp triangle of this formation at the point of the Lackawanna anthracite coal basin, (Forest City basin,) in the corner of Susquehanna county and the adjoining border of Wayne,—a patch of wilderness,—the strata dipping faster than the streams,—natural rock sections therefore few and isolated, and only one rib or bluff visible at a time. A detailed section at Forest City was therefore not attempted.

Further south, however, all the rocks of XII are well exposed on both sides of the basin.

Opposite Scranton on the southeast side of the basin, along the line of the Delaware, Lackawanna and Western railroad, up Roaring Branch creek, to the tunnel near the falls, I obtained the following section, shown in Fig. 1.

Upper division of XII.

1.	*Scranton Sandstone*, current-bedded, pebbly,	75′

Middle division of XII.

2.	Shale,	5′	180′
3.	*Coal* and coal-shale,	4′ to 6′	
4.	Shales and coal-shale,	20	
5.	Sandstone, buff,	20′	
6.	*Forest City (?) coal* bed,	5′	
7.	Fire-clay,	4′	
8.	Shales, blue, sandy,	20′	
9.	Sandstone, buff-white,	18′	
10.	*Coal-shale,*	3′	
11.	Shale, gray, sandy,	8′	
12.	*Coal* and coal-shale,	3′	
13.	Shale, bluish gray,	8′	
14.	Sandstone, buff,	35′	
15.	*Coal-shale,*	3′	
16.	Shale, gray,	5′	
17.	*Coal-shale,*	2′	
18.	Slate, dark, very bituminous, at base,	15′	

Lower member of XII.

19. Pebbly Sandstone,	25′	105′
20. Shale,	0′ to 2′	
21. Pebbly Sandstone,	30′	
22. *Coal-shale,*	½′	
23. Pebbly Sandstone,	12′	
24. Flaggy Sandstone,	15′	
25. *Coal-slate,*	½′	
26. Pebble Conglomerate, massive,	20′	

Sub-Conglomerate coal.

27. *Coal bed,*	0′ to 2′
Total thickness,	356′ to 362′

On the opposite side of the basin, and four miles northwest of the preceding, along the same railroad, in the gap, I obtain the same series of rocks, as shown in Fig. 2.

Upper division of XII.

1. *Scranton Sandstone,* current bedded,	60′

Middle division of XII.

2. *Coal,* impure,	2′	188′
3. Sandstone and shales,	35′	
4. *Forest City? coal* and coal-shale,	8′	
5. Fireclay,	2′	
6. Sandstone,	50′	
7. Shale blue,	5′	
8. *Coal-shale,*	3′	
9. Sandstone,	2′	
10. *Coal-shale,*	2′	
11. Shale and sandstone,	3′	
12. Coal-shale,	5′	
13. *Coal,* slaty,	1′	
14. Fireclay,	5′	
15. Sandstone,	35′	
16. Shales, olive,	30′	

Lower division of XII.

17. Conglomerate, very pebbly,	100′
Total thickness,	348′

At Forest City the middle and lower division of XII are made known in detail by a diamond-drill-hole put down by the Hillside coal and iron company, the record of which I was permitted to copy in the office of the Superintendent of the company, Mr. Hines, as follows; see Fig. 3.

Middle division of XII.

1.	Sandstone,			13′ 2″	191′ 4″
2.	Slate,			19′ 0″	
3.	*Forest City coal bed,*			3′ 6″	
4.	Slate,			2′ 2″	
5.	*Coal,*			0′ 6″	
6.	Slate,			2′ 9″	
7.	SANDSTONE, hard,		42′ 3″	84′ 10″	
8.	Slate,		1′ 9″		
9.	SANDSTONE,		8′ 8″		
10.	Slate,		7′ 4″		
11.	SANDSTONE, hard,		24′ 10″		
12.	Slate and *coal,*			2′ 10″	
13.	Slate,			10′ 0″	
14.	Sandstone, hard,			13′ 10′	
15.	*Coal bed,*	Coal,	1′ 6″	2′ 2″	
		Slate,	0′ 2″		
		Coal,	0′ 6″		
16.	Slate,			5′ 4″	
17.	Sandstone,			23′ 7″	
18.	*Black dirt,*			3′ 1″	
19.	Slate,			1′ 4″	
20.	*Dirt,*			0′ 8″	
21.	Slate,			2′ 7″	

Lower division of XII.

22.	Sandstone,	28′ 1″	88′ 5″
23.	*Coal,*	0′ 5″	
24.	Slate,	0′ 1″	
25.	PEA CONGLOMERATE,	24′ 10″	
26.	Slate,	4′ 9″	
27.	PEA CONGLOMERATE,	22′ 9″	
28.	Slate,	0′ 10″	
29.	Sandstone,	0′ 1″	
30.	Slate,	0′ 5″	
31.	PEA CONGLOMERATE,	1′ 2″	
32.	Slate,	0′ 9″	
33.	CONGLOMERATE, (bottom of hole,)	3′ 0″	
	Total of section, (as shown,)		279′ 9″

By comparing these sections with those published in Mr. F. Platt's report: 1, at Blossburg in Tioga county (G, p. 166–7) and 2, at McIntire in Lycoming county (GG, p. 124–5) and my own section of No. XII in Mercer county, a similar subdivision into Upper (conglomerate), Middle (coal bearing), and Lower (conglomerate) appears, their relative thicknesses being:—

	In Mercer co.	*At Blossburg.*	*At McIntyre.*
Upper, ...	50′	40′ to 60′	27′ (visible) +
Middle, ...	237′	100′	229′
Lower, ...	20′	55′	66′
	307′	215′	332′

and to render this easy of reference Mr. Platt's sections are reproduced here, as Fig. 4 and 5.

The thickness of the whole formation is somewhat greater at McIntyre than at Scranton and Forest City; and considerably less at Blossburg.

In Northwestern and Western Pennsylvania, Reports H, Q, R, V, &c. show XII subdivided into three sandstone deposits (separated by coal measure intervals); the Lower division being a persistent Conglomerate (*Sharon, Garland, or Olean*); and the whole formation measuring about 300′. (See for example Report QQQ, on Mercer county, page 33, the figure of which is reproduced here as Fig. 6.)

It looks very much as if the *Scranton current-bedded sandstone*, the McIntire *Upper Conglomerate*,* the Blossburg *Monkey ledge*, the *Johnson run rock* of McKean, and the *Homewood Sandstone* of the Beaver river country, were all the same.

Mr. Platt's description of the *Monkey ledge* rock of Tioga county (which I have myself verified on the spot) so closely fits the *Scranton Sandstone*, that I need only repeat it here in his own words (G, p. 168):—

"The Sandstone which underlies the Seymore Coal bed, is one of the most marked and persistent features of the Blossburg Coal Basin. It is known in all the different lo-

---

*It seems impossible to identify this with the Mahoning Sandstone of the west, because of its short height (295′) above No. XI; an interval scarcely sufficient to hold No. XII alone, without any of the overlying (Lower Productive) coal measures.

If my identification be correct it will have an important bearing on our nomenclature; for the coal beds *under* the Monkey ledge at Blossburg, and the coal beds *under* the Scranton Sandstone, have been accounted a part of the Lower Productive coal measures; whereas they should be regarded, I think, as Inter-conglomerate coals (Mercer, Quakertown and Sharon beds.)

Sections selected from the Reports of Progress in Lycoming, Tioga, and Mercer counties to illustrate the Pottsville Conglomerate (page 49.)

Fig. 4

Fall brook.

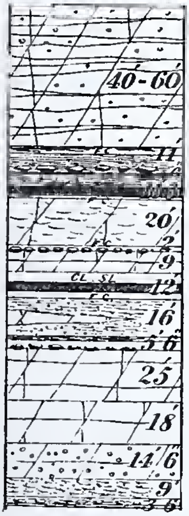


Fig. 5.

Mc. Intyre.

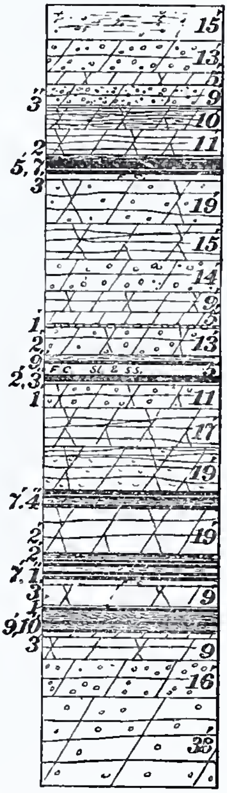
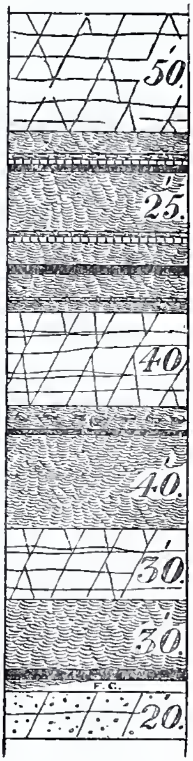


Fig. 6.

Mercer Co



calities as the "Monkey Ledge;" is from 40 to 60 feet thick, averaging 50 feet; is thin bedded usually, though with occasional massive plates, and is enormously current bedded, with numerous layers of conglomerate-sandstone scattered through the mass at no regular intervals, usually in thin plates, with white, rounded quartz pebbles, always recognizable; and it is usually noticeable by making cliffs near the hilltops. It is the great mark and guide to the geology of the basin."

The Scranton Sandstone is well exposed along the railroad, about half a mile south of the dêpot, and in many other places around.

It is the first great pebbly Sandstone mass above the lowest *workable* coal of the Scranton region, and easily recognized by its extraordinary oblique lamination.

Its color is dark gray, in portions almost black.

It contains very numerous small white quartz pebbles.

It makes the great cliffs of the east bank of the Lackawanna half way between Carbondale and Forest City.

It may be seen again just south of Forest City; but to tell how much it has escaped erosion in that neighborhood would require a minute survey. Probably this is the rock of the bold ledge on the east bank of the Lackawanna just above Forest City, extending around the mountain; and it is probably the first sand rock of the diamond-drill boring.

The Forest City coal bed lies 20′ to 30′ beneath the base of the Sandstone above described, and is the lowest workable anthracite bed at this end of the basin; extensively worked along Roaring run near Scranton; and the only workable bed at Forest City; where the Hillside Coal and Iron Company has a colliery, shipping 30,000 tons per annum over the Jefferson branch of the Erie railroad.

Its average thickness is 5′, according to Mr. Hines, thickening occasionally to 6½, thinning frequently to 4′ and 3′, and sometimes to nothing.

Its usual roof is a dark slate; in some places replaced by a dangerous sandstone.

An area of 70 acres has been mined out and there may be as much left to mine; all in the corner of Susquehanna county, close up to the Wayne county line; beyond which the bed has not been found, and does not probably exist; for the rise in that direction is rapid.

The Bottom conglomerate is separated from the top rock (*Scranton sandstone*) by 179′ or 188′ of measures, at Scranton, (Figs. 1 and 2,) and 179′ at Forest City, (Fig. 3,) supposing the 13′ sandstone of the bore hole to represent the bottom layers of the *Scranton sandstone*, and the 28′ 1″ of the bore hole to represent the upper member of the *bottom conglomerate*. But the details of this interval, in both the Scranton sections, were not measured with absolute accuracy, the rise being pretty steep; but their relative thicknesses must be a close approximation to the truth; the maximum of error in either section cannot exceed 10′ or 15′.

The sand-rock layers in this interval are mostly bluish-gray; quite hard; generally free from pebbles; and, individually considered, variable in thickness, without affecting seriously the regular thickness of the whole.

The Bottom conglomerate, which at Scranton, on Roaring run, is about 100′ thick,* very massive, but split into several distinct layers, separated by very thin shales or coaly slates, is subdivided in the same manner at Forest City, as the diamond-drill record shows.

The rock is always quite pebbly, although a few of its layers may be quite free from them; but towards the bottom the pebbles become more plentiful and larger; often 2″ to 3″ long by 1″ to 2″ thick; most of them rounded, or water-rolled; most of them of white quartz, sometimes stained a dirty, yellowish brown; imbedded in a matrix of coarse sand, varying in color from buff to gray, and occasionally of a somber mud color. I met with places where the lower part of the mass was a mere mass of pebbles (quartz) cemented together. Between Waymart and Carbondale, for example, a 20′ ledge of snow-white quartz pebbles, at the very base of XII, has been quarried for glass sand.

In the few hundred acres occupied by this formation on both sides of the mid-county line, no complete exposures of it can be found, because its dip is precisely equal to the fall of the mountain brooks in the ravines opposite Forest city, where the top layers are exposed for a long distance up the Moosic mountain.

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* Prof. Rogers makes the average thickness of XII in the Scranton coal-field 80′. (See Geol. Penn. 1858, Vol. II., p. 239.)

The equivalence of this *Bottom conglomerate* of XII on the Lackawanna with the 60′ rock under the *Bear creek coal* in Tioga county looks probable; but its equivalence *as a whole* with the *Olean-Garland-Sharon conglomerate* of the northwestern counties is doubtful; the principal objection being the fact that a coal bed underlies the 100′ conglomerate at Scranton (which would represent the *Kidney bed* under the 60′ conglomerate at Blossburg), whereas the *Sharon coal bed overlies* the Sharon conglomerate. But on the other hand coal and *black slate* underlie the Olean (Sharon) conglomerate as far west as McKean county.*

But the lowest 20′ of the Bottom conglomerate (separated at Scranton (Fig 1) from the upper 80′ by a *coal-slate* layer,) greatly resembles the *Olean-Garland-Sharon conglomerate* in the quantity, quality and (what is more important still) in the *shape* of its pebbles, and in the character of their matrix.

During the summer (1880) I made a careful study of the Fallbrook (Blossburg, Tioga county) coal section, and incline to the view that the *Kidney bed* may be regarded as the equivalent of the *Sharon bed* of the west. I found two or three species of plants (*Lepidodendra*) in the roof shales of the *Kidney coal* which are very common in the *Sharon coal.* Also a *Whittleseya?* too ill-preserved to be certainly identified. Should undoubted specimens of *Whittleseya elegans* be found in the *Kidney coal* shales, I would consider the question settled; for this plant is peculiar to the *Sharon coal bed.*

Sub-conglomerate coal. The bed frequently seen under the ovoid-pebble conglomerate,† and sometimes as much interleaved with the basal layers of the conglomerate as under-

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*Mr. Ashburner's *Lower Marshburg coal bed.*

†This epithet has become useful in designating the *Olean-Garland-Sharon conglomerate.* (See Reports I.I.I, Q^3, Q^4, R. &c.)

lying it, is well exposed at the new Water Works dam on Roaring branch, 3 miles from Scranton; from 1′ to 1′ 6″ thick, often thinning out entirely. It may be seen also along the descent of the stream flowing from Pond No. 4 towards Carbondale.

Fig. 7a. Fig. 7b. Fig. 7c.

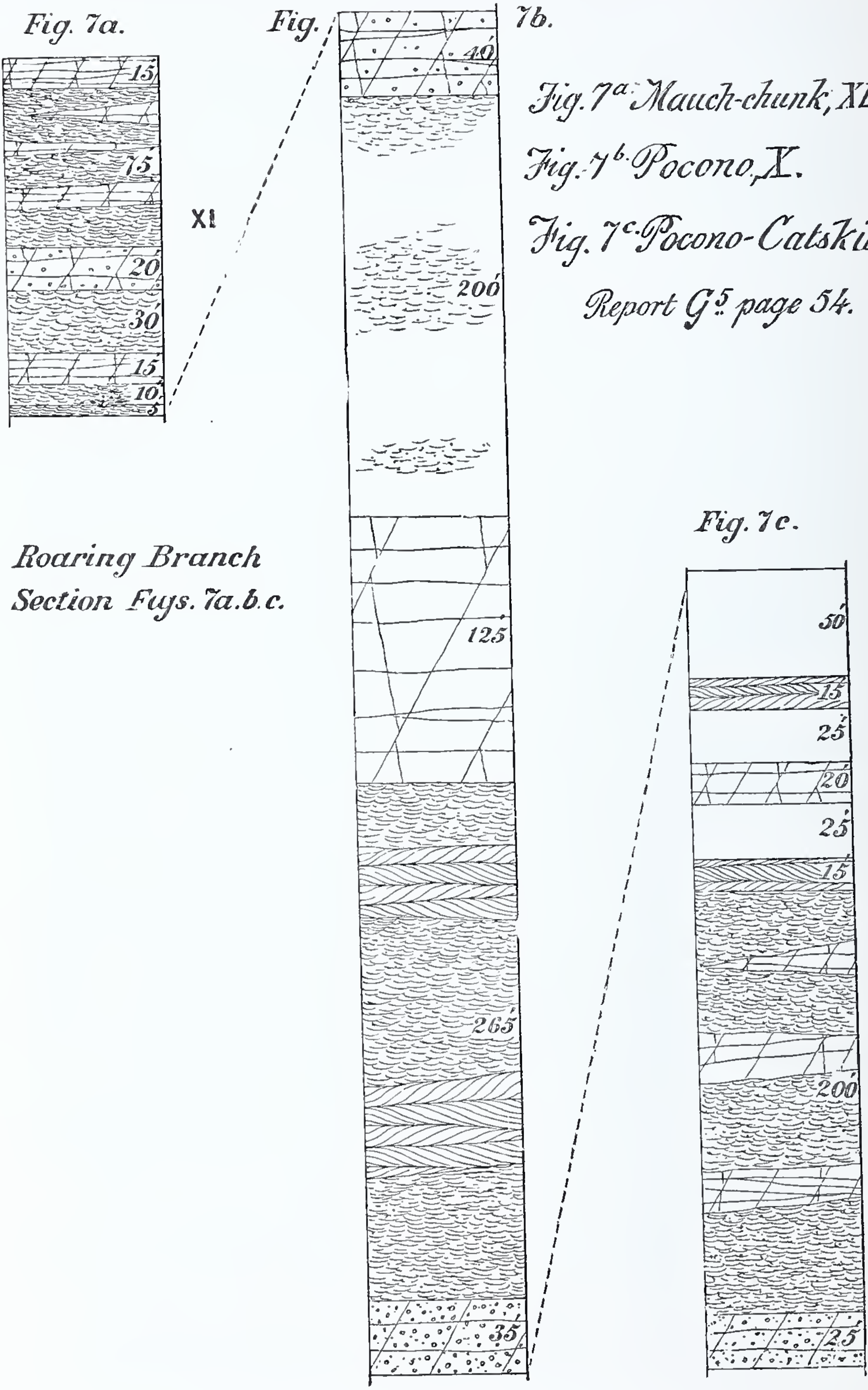

Fig. 7a: Mauch-chunk, XI.
Fig. 7b. Pocono, X.
Fig. 7c. Pocono-Catskill
Report G.5 page 54.

Roaring Branch
Section Figs. 7a.b.c.

Chapter VI.

Subcarboniferous Measures.

Mauch Chnnk red shale, (No. XI,)	170′ ?	1210′
Pocono sandstone, (No. X,)	665′ ?	
Transition (*Sub-Pocono*) measures,	375′	

Mauch Chunk red shale.

The measures immediately below the Pottsville Conglomerate are so seldom and so badly exposed along the Susquehanna-Wayne county line, that no good section of them can be made from surface shows.

But at Scranton excellent exposures may be found along Roaring branch, as follows, (see Fig. 7 *a.*)

1. Sandstone, very hard, buff, in thin layers,	15′
2. Sandstone, buff, and shale,	75′
3. Sandstone, grayish white, *pebbly*,	20′
4. Shales, buff, sandy,	30′
5. Sandstone, gray, hard,	15′
6. Shale, *reddish*,	10′
7. Shale, dark,	5′

It is difficult to imagine that these mostly hard, gray, sandy, and even pebbly deposits—constituting a formation only 170′ thick, and with only 10′ of reddish shale—can represent the 3000′ of deep red shales at Mauch Chunk (and along the south border of the Pottsville anthracite coal field for a hundred miles) only 40 miles in a direct line south from Scranton. But the Mauch Chunk formation visibly surrounds all the anthracite basins, in the Roomrun, Quakake, Locust, and Catawissa valleys, and can be followed up along both sides of the Wyoming basin, past Wilkesbarre to Scranton; its red shale character preserved as far as Wilkesbarre and Pittston; but its thickness constantly diminishing. There can be very little doubt therefore about the identity of the Scranton, Carbondale and Forest City subconglomerate layers, although the soft and red shaly constitution has nearly disappeared.

The sandstones of the section, however, if they belong to the *Mauch Chunk formation* No. XI, wear a remarkable lithographical resemblance to the typical rocks of the *Pocono formation* No. X; and the cutting off of the section at the dividing plane between the bottom of the 5′ dark shale (7) and the top of the 40′ pebbly sandstone (8) is arbitrary and hypothetical.*

There seems to be more shaly layers and fewer sandy layers in the formation outcropping on the northwestern side of the basin; but the whole thickness remains about the same.

B. *The Pocono Sandstone* formation continues the section downwards thus:—Fig. 7, *b:*

8.	Sandstone, buffish-white, *pebbly*, ...	40′
9.	Shales, buff, sandy, and concealed rocks,†	200′
10.	Sandstone, buffish-white, *massive*, ...	125′
11.	Shales, with sandstone, gray, current-bedded, ...	265′
12.	*Griswold's Gap Conglomerate*, white, very pebbly, . .	35′

The 40′ rock (8) is very massive and contains very many white quartz pebbles, and would certainly be identified with the Sub-Olean Conglomerate were our section made in the northwestern counties of the State.

The 200′ buff shales (9) could not be exactly measured, and the thickness may range between 175′ and 225′.

The 125′ sandstone (10) has all the *Pocono* characteristics. Along Roaring branch it is an uninterrupted pile of layers, varying from 1′ to 4′ in thickness, of moderately fine-grained, very hard, somewhat current-bedded, buff colored sandstone.—Just below Greenville it dips N. W. into the water at an angle of 10° to 12°.—In a notch of the Lackawanna mountain, northwest of Oliphant, it is seen, 100′ thick, dipping to the southeast.—Its resemblance to the *Corry Sandstone* of Erie county is very striking.*

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* Others may prefer to include in No. XI, the 40′ pebble rock (8) and the 200′ of shales (9,) and draw the line of the top of No. X at the top of the 125′ sandstone (10 of Fig. 7, b.) This would increase Formation XI to 410′.

† Estimated thickness.

The 265′ of shales (11) includes several beds of grayish-white, tolerably coarse, current-bedded sandstone.† — On Roaring branch, we see from 200′ to 250′ of reddish-olive-colored shale, in which no sandstone layers are noticeable ; and then more shales below, in which sandstone layers occur.

The 35′ *Griswold Gap Conglomerate* (12) is a remarkable horizon. In the whole 800′ to 850′ interval between it and the *Bottom Conglomerate* of XII, our section of *Mauch Chunk* and *Pocono* rocks has not exhibited a deposit in which the quartz pebbles are numerous, large or persistent enough to warrant the name of a conglomerate. But at this horizon lies a true conglomerate, so solid and massive as to make the crest of the Moosic mountain.

In the notches of this crest the rock can be studied all along the western border of Wayne county, and it has two fine sloping outcrops on the opposite side of *Griswold's gap*, just east of Forest City, on the road to White Oak pond.

Its outcrop from this gap can be followed, northward, to near Mt. Pleasant, usually on the eastern slope of the mountain crest ; and southward, across the Wayne county line into Lackawanna county, about 5 miles south from Waymart.

Its pebbles, very white, are somewhat angular and flattish rather than ovoid, vary in size from ½″ to 2″, and rest in a rather coarse, brownish-gray matrix weathering whitish.‡

Fish bed of Rix's gap.—A calcareous layer, 2′ to 3′ thick, outcrops near the base of the *Griswold Conglomerate*, just west of Waymart, in Rix's gap. *Pebbles of red shale* and *greenish shale* and *many fish remains* are mixed with the ordinary quartz pebbles.

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* The top of the *Corry Sandstone* is only 280′ beneath the *Sharon Conglomerate* in Erie county, while the top of this (*Lackawanna*) sandstone is 410′ beneath the *Bottom Conglomerate* at Scranton; but the whole Palæozoic column thins westward.

† Thickness estimated. It cannot be less than 250′ nor more than 300′.

‡ I would compare this formation with the *Cussewago Sandstone* of my Erie county report, Q^4.

C. Transition layers, Sub-Pocono.

A markedly different kind of sediments from the conglomerate just described occupy the next 375′ as follows :

Fig. 8.

13.	—— Concealed for	50′
14.	Sandstone, gray, current-bedded,	15′
15.	—— Concealed for	25′
16.	Sandstone, grayish white,	20′
17.	—— Concealed for	25′
18.	Sandstone, gray, current-bedded,	15′
19.	Sandstone, gray, layers; and Sandy shales, reddish,	200′
20.	MOUNT PLEASANT CONGLOMERATE,	25′

The North and South Knobs of the Elk mountain range are made by this group.

Mount Ararat and the Sugar-loaf of the Moosic mountain range, are similar isolated heights preserved from erosion by outlying patches of this group ; 250′ to 300′ of the section being visible on and around their summits ;—horizontal plates of coarse, grayish-white, current-bedded sandstone (often streaked with layers of small quartz pebbles), each from 15′ to 25′ thick, and separated by beds of sandy shale (some of them, especially those low in the series, of reddish hue) from 20′ to 50′ thick.

*The Mount Pleasant Conglomerate,** at the base of the group is a massive grayish white sand rock, 20′ to 25′ thick, through which pebbles of quartz are scattered, and sometimes in such abundance as to constitute it a conglomerate.

Even where the whole mass is most of a sandstone, there is always a *pebbly portion near the bottom*, 3′ to 6′ thick ; and the pebbles in this lower portion are *reddish* or *rose colored*, in striking contrast with the white pebbles of the *Griswold gap conglomerate.*

Fish bed :—A calcareous conglomerate, 2′ to 3′ thick, forms the base of the *Mt. Pleasant rock*, like the *Griswold gap rock* :—quartz pebbles, pieces of shales, and *fragments of fish bones* (to all appearance) so worn as to be undeterminate.

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*The summit of the hill at the village of Mt. Pleasant is capped by it.

At Mount Pleasant village is an outlying patch of this formation, about half an acre in extent. Here its pebbles are quite large.

Prospect Rock, is a broad table of it; and its long lines of cliffs look out from the east and west sides of the South Knob of the Elk mountains.

In Ararat Peak it is very conglomeritic, and the people, mistaking it for the *Bottom conglomerate of XII*, believe that coal beds exist in the 300′ to 400′ of measures which form the cone of the mountain over it; which of course is a mistake.

In Sugar Loaf peak it outcrops again.

Along Moosic mountain slope, facing east, in Wayne county, its outcrop can be traced from Mt. Pleasant southward to the Lackawanna county line; and in that direction the rock seems to become a coarser conglomerate.

CHAPTER VII.

Catskill formation, No. IX.

If the transition strata described in the last chapter be placed in this formation they will increase to 1905′ the 1530′ of the following general section, Fig. 8:

1.	*Mt. Pleasant red shale,*			150′
2.	*Elk mountain* shales and sandstones,			150′
3.	*Cherry ridge.*	CONGLOMERATE,	20′	170′
4.		Gray shales,	20′	
5.		Sandstone,	15′	
6.		*Limestone,*	5′	
7.		*Red shale,*	110′	
8.	*Honesdale Sandstone,*	Upper, white,	25′	90′
9.		Middle, red,	40′	
10.		Lower, gray,	25′	
11.	*Montrose red shale,*			180′
12.	*Paupack sandstone,*			25′
13.	*Paupack shales,* red and green, and sandstone,			200′
14.	*New Milford,*	Sandstone, upper,	40′	460′
15.		" middle,	300′	
16.		" lower,	20′	
17.		Red and olive shales,	100′	
18.	*Starrucca* gray and olive shales with thin sandstone,			105′
	Total thickness of undoubted Catskill,			1530′

The question of the propriety of including or excluding the upper transition beds in this estimate is left open; but there is certainly no such strong and decided break in the whole series of 2740′ from the base of the Pottsville conglomerate to the base of this Catskill series, as occurs at the base of the Pottsville.

The only notable difference between this series and those above it, already described, consists in a greater percentage of *red rocks.* But in none of the exposures does it exceed 40 per cent.; often not 20 per cent. of the mass. Moreover the red beds when traced short distances become gray and only the thicker strata seem disposed to hold their color.

The proportion of sandstone beds to shale beds may be called about 40 per cent.

The sandstone beds vary in thickness from 2′ to 10′ and are characteristically false or current-bedded. The lamination, as exhibited in the cliffs, is very curious. Each of the horizontal beds are crossed obliquely by lines an inch or two apart, weathered into furrows. The slope of the furrows in one bed will be in one direction; that of the beds above and below in the opposite direction. The ends of the furrows meet along the horizontal lines of stratification at an acute angle. Consequently, when a considerable number of these sandstone beds, lying upon one another, are exposed to view, the whole face of the cliff is sculptured in zigzags from top to bottom.

This false bedding sometimes shows regularly straight and parallel lines; at other times the lining is curved and the laminæ overlap each other at the bottom; but at the top they are cut off square.

All geologists agree that this appearance can only be explained by supposing the sand to have been deposited in strong currents of water; that the direction of the currents was continually changing; and that when the current changed it planed off the tops of the sand layers which had been previously deposited.*

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*For a sketch of this kind of stratification in the neighboring counties of New York, see Lardner Vanuxem's Report of 1844, Third district, New York Geology, page 187, fig. 53.

Catskill Section Nº IX.

Fig. 8a.

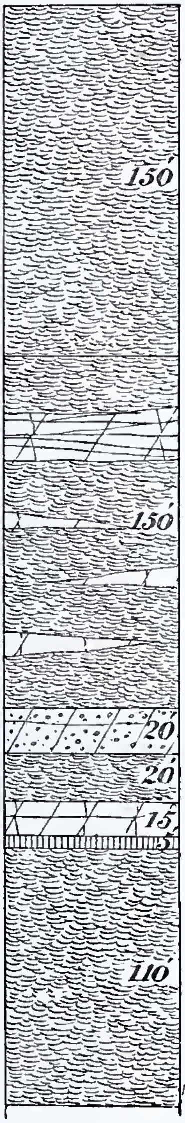


Fig. 8b.

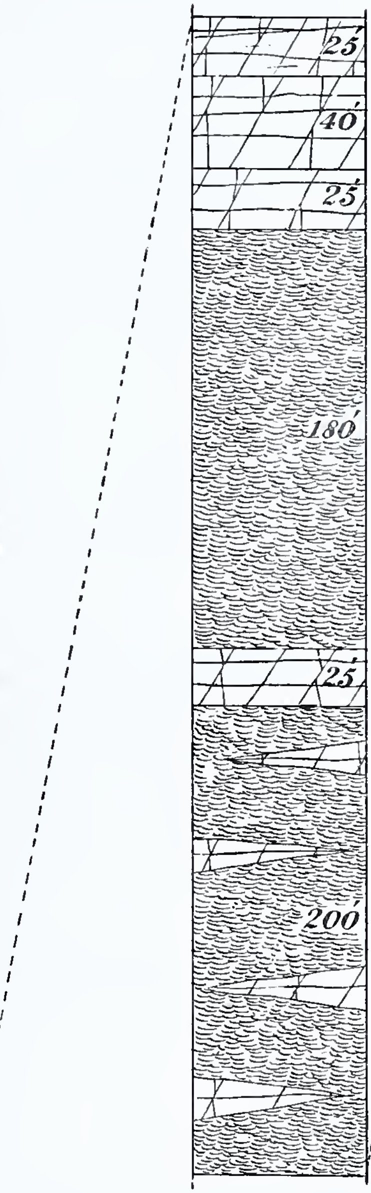
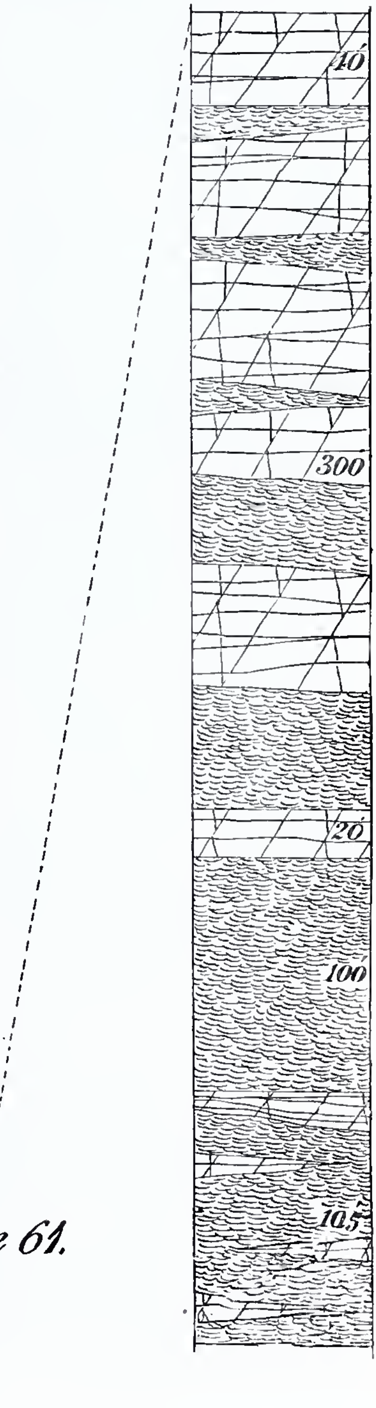


Fig. 8c.



To illustrate Report G^5 page 61.

These sandstone beds make cliffs everywhere throughout the district, and are usually from 20′ to 30′ thick, succeeding each other at intervals of 20′ to 40′; the intervals being filled with beds of shale.

Although seeming quite massive externally, from the long lines of cliffs which they form, yet when quarried into they are usually found to be laminated in small regular layers, from 1″ to 3″ thick, and not at all corresponding to the zigzag lines of the weathered surface.

The color of the *Catskill sandstone* is usually a grayish-green, varying to olive in the interior.

Calcareous breccias:—Another very common characteristic feature of the sandstone beds of the *Catskill* is the occurrence of a layer of *calcareous breccia* at their bases. This feature is also seen in the *Pocono sandstone* formation No. X although not so frequently. Sometimes these masses thicken up to 5′ and even 8′, and then assume the appearance of impure limestones.

Mr. Vanuxem accurately described these layers thus: "A peculiar accretionary or fragmentary mass, appearing like fragments of hard slate, cemented by limestone. This mass though usually but a few feet in thickness, where it is thickest in the district, is a constant associate of the group. It has not received a name with us, but is well known in England by the name of *cornstone;* and there also, from what we read, it is confined to this group."*

The *calcareous breccias* which everywhere accompany the *Catskill rocks* in this district, frequently contain pebbles of sandstone, and sometimes of quartz. The *pieces of slate* are nearly always of a dark olive hue, and present much the appearance of a "slickensided" surface. They also frequently contain what seem to be fragments of *fish bones*, so broken and worn as to be indeterminable. The calcareous matter often presents a fragmentary appearance, as though it had been formed by the erosion and breaking up of an older limestone.

No valuable *minerals* occur in any appreciable quantity in the *Catskill rocks* of the district. Thin strings or streaks of *coal* from ½′ to 1″ thick are sometimes found in some of the sandstones, and in a few cases have led to a considerable outlay in prospecting for *coal;* but it can be stated with the fullest assurance that no workable beds will ever be found.

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* Geology of New York, 1844, Third District, p. 186.

At some localities small quantities of wad, or black oxide of *manganese* are found scattered through the *Catskill sandstones*, but never in sufficient quantities to warrant mining.

Traces of *copper glance* are also found occasionally; and at one locality near Honesdale *copper* and *nickel* were found in small quantities in *red shale*, but in such small amount and so distributed through the rock as to be of no value.

In Manchester township, Wayne county, a good deal of time and money was once wasted in prospecting one of the *Catskill sandstones*, iron-stained and specked with mica, which was mistaken for gold.

Catskill Fossils.—The only vertebrates seen in the Catskill rocks of either county are the supposed *fish fragments* in the *calcareous breccias.*

Plant remains are seen occasionally; among which is the *Archæopteris Jacksoni*, found by Prof. Dolph in the *Paupack sandstone*, opposite Honesdale. Fragments of leaves and stems are often seen too badly preserved for even generic determination.

As for shells, I have not noticed a single specimen of a *molluscan fossil* in the *Catskill* rocks anywhere within this district: if any exist they must be exceedingly rare.

Mount Pleasant red shale (1), 100′ thick is very well exposed along the road descending from the village, westward; has a uniform, dull, dark red color; and shows no sandstone layers. Also, under Prospect Rock, in the South Knob, Clifford township.

The general erosion of the country in both counties limits the present area of this red shale to isolated patches in the higher ridges and hill-tops.

Elk Mountain gray shale (2), 150′ to 200′ thick, covers a much wider area of the district, but is seldom well exposed to examination. Its outcrops around the slopes of the North and South knobs of the Elk mountains, show that it consists largely of grey, red, green and spotted shales, with few sandstone layers. But in other localities a good many grey, current-bedded sandstone layers go to make up the mass.

Cherry Ridge group.—This consists of an upper division of coarse and fine sand, 55′ thick, a middle *limestone* bed, 5′ thick, and a lower division of *red shale*, 110′ thick (=170′ in all); well exposed near Cherry Hill P. O. Wayne county; but very extensively outspread in both counties.

Cherry Ridge conglomerate (3), (capping Collins' high knob just west of Cherry Ridge P. O.) It is usually 20′ thick, but sometimes 25′; a grayish white, very hard rock, filled with *reddish-quartz pebbles* through the southern half of Wayne county; but in the northern half of Wayne county the pebbles are scattered through it only in some localities.

In Susquehanna county this conglomerate seems to have been eroded from the whole country except along the highlands of the eastern townships. It is a prominent feature of the surface in the Elk mountains, and along the plateau to the northward.

A *calcareous breccia* is often found at its base, which in Southern Wayne county is itself full of quartz pebbles. In eastern Susquehanna county this breccia is a *black* stratum, 5′ thick.

Cherry Ridge shales (4,) 20′ to 25′ thick, usually of greenish, or olive color, separate the conglomerate from the underlying sandstone.

Cherry Ridge sandstone (5,) 15′ thick, gray, current-bedded, forms with the underlying limestone, a conspicuous rock ledge at hundreds of localities in all parts of Wayne county; but followed southward into the southern townships it is seen becoming coarser and finally well supplied with reddish-white quartz pebbles. In the general geology of

Eastern Pennsylvania, therefore, this pebbly sandstone, the shales above it, and the overlying conglomerate, must be grouped together and regarded as one important sandstone sub-division of the Catskill formation, lying between two shale sub-divisions, the lower one *red.*

The crevices of this sandstone, at Mr. Collins' near Cherry Ridge P. O. are studded with beautiful rock crystals, some of which are more than an inch long.

Cherry Ridge limestone (6).—This is one of the most remarkable and persistent of the Catskill strata; extending over a large part of Wayne county, and the eastern tier of townships in Susquehanna county; always immediately under the sandstone, and in fact a part of it; for, while the average thickness of the calcareous part of the rock may be called 5′, it varies greatly, rising here and there into the sandstone beds, and the sand descending elsewhere into the limestone bed.

In respect of the great area occupied by this limestone it differs essentially from all the other calcareous breccias, higher or lower in the series; for these all seem to be very local deposits, appearing and disappearing suddenly in short distances.

But in respect of the amount of carbonate of lime in the rock it cannot be said to deserve the name of *a limestone.*

It is an agglomerate of chips of slate or shale—fish bone fragments—pieces of fossilized wood—and often a large quantity of sand—all cemented together by lime.

Analyses of Mr. McCreath at Harrisburg show how extreme are the variations:

CHERRY RIDGE LIMESTONE.	*a.*	*b.*	*c.*	*d.*
Siliceous material,	28.800	65.470	75.220	80.950
Carbonate of lime,	64.392	19.785	17.696	11.196
Carbonate of magnesia,	1.816	3 518	1.589	1.664
Oxides of iron and alumina,	4.145	8.903	4.432	4.988
Phosphorus,	0.050	0.095	0.034	0.036

a. Schenck's quarry, Cherry Ridge township, Wayne county; specimens from the richest part of the rock.

b. Specimens from the poorest part of the rock.

c. d. J. Multen's land, Oregon township, Wayne county.

By carefully selecting the rock Mr. Schenck's kiln has turned out a fair farming lime, most of it slacking to a fine powder, although pieces refuse to slack, and there is some slag.

The effect of a liberal use of it on the soil is reported to be greater than that of barn-yard manure. As similar rich parts of the outcrop ought to be discoverable in other parts of the region, and as loose bowlders from its innumerable lines of outcrop lie scattered all over Wayne county, and the eastern part of Susquehanna county, the subject deserves the close attention of farmers.

The solubility of the rock appears from the blackish brown appearance of its weathered surface; hence the bowlders are called *nigger-heads;* and are from 2′ to 10′ in diameter; a proof of the massive solidity of the stratum.

The more silicious portions of the stratum are extremely hard, as the drillers discovered in cutting through it on the Jefferson Branch railroad line.

Its black outcrop can be traced from the roadside near Cadjaw pond (1 mile S. W. from Honesdale) northward along the Lackawaxen and its tributary streams over the highland nearly to the New York State line;—southward from Cherry Ridge to the south line of the county; and from the Elk mountains, around which it runs in a black line, 8′ to 10′ thick, 600′ to 700′ below their summit, northward along the highlands nearly to Starucca.*

Cherry Ridge red-shale (7), 100′ to 110′ thick;—persistently underlying the limestone throughout the region; often sub-divided by a middle 15′ to 20′ gray, current-bedded sandstone, and sometimes including two or three additional thinner sandstones.

The Honesdale Upper Middle and Lower Sandstone group is well marked throughout Eastern Susquehanna and most of Wayne county. At Honesdale in Wayne county it is *well exposed* and easily divisible.

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* In the second part of this report, on the geology of the separate townships the reader will find described the local exhibitions of this rock, which is propably referred to as the *Catskill limestone* in the New York State reports of 1844.

At Montrose in Susquehanna county, this group of rocks forms the high band near the Fair Grounds, but no division can be made.*

Honesdale white sandstone (8), 25′ thick.—This upper member of the group is so nearly white in comparison with all the other Catskill strata that its outcrop can be seen from a distance passing from hill to hill over the country. It is often current-bedded, and towards Pike becomes a regular conglomerate. In spite of the whiteness of its weathered surfaces, it is really when freshly broken dark-colored, or rather of a grayish-brown, owing to numerous specks of peroxide of iron. When these are weathered out the surface is left grayish-white. One of its good exposures is the long line of cliffs near J. Burn's, a mile south of Honesdale. Many others will be mentioned in the township report.

Honesdale red sandstone (9), 40′ thick.—This middle member of the group is unique in one respect; it is the only red *sandstone* in No. IX, the other red rocks being all *shales*. Its color however is *light-red*, showing that the specks of peroxide of iron are much more numerous than in the rock above. The stone is quite hard, fine-grained, usually thinly laminated, and often contains a good deal of argillaceous matter. Many rounded blocks of it are scattered through the Drift deposits.—The *Irvine cliff* opposite Honesdale is capped by these red rocks.

Honesdale gray sandstone (10,) usually 25′ but sometimes 50′ thick. This lower division of the group is a series of quite massive, gray, usually current-bedded layers, forming the two miles of cliffs along the Dyeberry above Honesdale.

Irvine's cliff, opposite Honesdale, is 300′ high and nearly vertical to the bank of the Lackawaxen.—No pebbles were seen by me in this rock throughout the country north of Honesdale; but going south and southeast it becomes a regular conglomerate, as on the hilltop east of White's Mills. Exposures can be found nearly up to the New York State line; its last outliers on the northward rise being in Scott township. In Middle Susquehanna county I saw it occasionally capping hills; but not so readily distinguishable from the other Catskill rock, as in Wayne county.

**Montrose sandstones* is a term which I have freely employed in my township reports, uncertain how much of the section in the hilltops around Montrose (over the red-shale) ought to be restricted to the Honesdale sandstone group. Vanuxem in 1844 applied the term *Montrose Sandstone* (*Oneonta*) to distinguish one division of his Catskill, but seems to have looked upon it as the lowest division of the formation; whereas I find 500′ of Catskill measures still beneath drainage level at Montrose.

Montrose red shale (11), 180′ thick.—This is seen along all the principal streets of the borough, wherever cuttings have been made, and is especially well exposed on the road descending the Wyalusing creek. It is equally evident on the hill roads around Honesdale; and the upper part of it just under the sandstone cliffs makes a great red show from afar. Two thirds of the mass, at least, in the Montrose country consists of red shale; the rest of several intercalated beds of gray sandstone. Around Honesdale there is at least 150′ of red shale; the rest being intercalated gray sandstones.

The Honesdale "copper and nickel shale" of the old reports lies at the very top of the red shale mass.

Paupack sandstone (12), 25′ thick.—From large quarries in this beautiful, bluish-green, serpentine-like rock, the silk factory at the mouth of Paupack, and churches in Honesdale have been built. It is probably confined to Southern Wayne county, for I found nothing to correspond to it elsewhere in the region.

About 200′ of greenish-gray, current-bedded sandstones, interstratified with green, olive, and occasionally red shales, underlie the Paupack quarry rock, and spread throughout the district in a manner so uncharacteristic that I hesitate to propose a name for these deposits.

The *New Milford group*, finely displayed in that part of

Susquehanna county, consists of about 360′ of gray and greenish-gray, current-bedded sandstone, overlying 100′ of red and olive shales; and the sandstone mass subdivides itself into upper, middle, and lower, 40′, 300, and 20′ thick respectively, in varions parts of the region.

New Milford upper sandstone (14), 20′ thick.—This is a massive looking, grayish, current-bedded stratum, conspicuous in long lines of bold cliffs near the hill tops of northern and central Susquehanna county; well seen from where the New Milford and Montrose road looks down upon Martins creek;* in the rock-cut at the hill top on the road from Summerville over to Great Bend; and in the Hinkerman Ledge north of Great Bend.

New Milford middle sand and shales (15) 300′ thick.—Greenish-gray, current-bedded sondstone 20′ to 25′ thick, regularly alternating with shales (some of them red) from 30′ to 50′ thick, outcrops on the side slopes over a great extent of country in northern Susquehanna county.

New Milford lower sandstone (16) 20′ thick.—This lowest of the *Catskill* current bedded sandstone deposits makes a fine show in the hill opposite the New Milford depot, 70′ above the R.R. and 1150′ above tide.

It is especially valuable as a guide to the geologist in search of the upper limit of the Chemung (200′ beneath it,) because it can be traced from the New Milford depot in an almost unbroken line of cliffs all the way north to Great Bend, where as the "*Fort '76 Cliff*" rock it overhangs the Susquehanna river more than 400′; and can thence be followed along the right bank, in frequent cliffs, past Susquehanna Depot, a mile beyond (below) which it circles round the hills at 375′ above the river level.

From Susquehanna Depot, northeastward, along the line of the Erie railroad, its outcrop rises, until at the Summit Cut (5 miles north of the State line) it lies 150′ above R.R. grade,=1525′ A. T.

Southeastward from the Summit Cut the dip carries it it down until, at Deposit on the Delaware river, its outcrop is only 100′ above water level=1050′ A. T.; and at the State line beneath the river bed; nor is it seen again as far as Pike county.

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*One and a half miles from New Milford, where the rock lies 1500′ A. T.

On the Bradford county line its outcrop lies about 200′ above the bed of Wyalusing creek.*

In the southwest corner of Susquehanna county *flagstone quarries* have been opened in greenish-gray layers from 2″ to 4″ thick, the flaggy stratum being seldom more than 20′ thick.

Many *plant fragments* occur at the quarry on Tuscarora creek, 1¼ miles west of Skinner's Eddy, 240′ above Susquehanna water-level.

New Milford red shale (17), 100′ to 120′ thick.—This deposit, concealed at New Milford, shows just south of the village, and is finely exposed along the D. L. & W. railroad half way to Montrose depot, as a *deep red* shale, with occasional sandy layers, in which are irregular deposits of *calcareous breccia.* Along Starucca creek the formation has very few red layers, but consists almost entirely of *olive* and *greenish* shales. In Wayne county the formation is *everywhere* beneath water level.

Starucca olive shales (18), 105′ thick.—These olive, or greenish shales contain numerous thin sandstones at short intervals, and is topped in some places with one more massive. The only good exposure south of the State line is along Jefferson Branch railroad above Starucca bridge. But the whole series (with the red shale above it) is perfectly exposed along the Erie railroad, in the Summit cut, on the divide between the Susquehanna and Delaware rivers.

General observations on No. IX.

1. *The thickness* of the Catskill formation, got by addi-

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* The New Milford group as a whole occupies a large area in eastern Bradford county which on the geological map is wrongly colored *Chemung.*

tion of the thicknesses of the subdivisions, (1530′) can only be approximately correct for any given part of the district, because the *upper subdivisions* have been measured in southeastern Susquehanna and middle Wayne, while the *lower subdivisions* have been measured in middle and northern Susquehanna county.

What the thickness of the lower subdivisions may be underneath Wayne, only bore-holes can determine, and we cannot now find out in any way what the original thickness of its upper subdivisions was in northern Susquehanna, for they have been all removed.

It is plain enough that the whole formation was thicker towards the south and southeast, and thinner towards the north and northwest.* Therefore, while 1500′ may be a large total for the formation as it originally existed on the Bradford county line and along the New York State line, it is probably much too small a total for the whole formation under southern Wayne. This the future survey of Pike and Lackawanna counties will reveal.

At Mauch Chunk and Pottsville the nearly vertical outcrops of the Catskill mass may be easily measured, and its thickness was reported by the First Geological Survey at about 5000′.

In the Hudson river face of the Catskill mountain Mr. Sherwood's detailed section (Report R, p. 219) sums up 2400′.

2. The areas colored as *Chemung* on the geological map accompanying Report G along the eastern border of Bradford, and naturally extending over into Susquehanna county, should, in my opinion, have been colored as *Catskill*; because, in nearly every place where I have seen the surface of these areas I have found it occupied by what I have classified as the lower groups of the Catskill formation, and have thus colored them on the geological map accompanying this report; the only genuine *Chemung* area being in the northwestern corner of the county. Elsewhere along the western border the *New Milford lower sandstone* and rocks overlying it occupy the ground. I suspect that

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*The individual strata grow coarser and thicker in that direction, gravel replacing sand, and sand replacing mud in their constitution.

a considerable part of Bradford county lying east of the Susquehanna river ought to be colored *Catskill* where the map colors it *Chemung.*

3. Before commencing my survey I studied the Blossburg section from XII down to VIII along the Tioga river, and give it here for comparison with all that has been said above (See Fig. 9.)

1.	Bottom conglomerate of XII,		60′
2.	—— Concealed (with red shales and gray sands,) XI,		245′
3.	Sandstone, buff, massive,		20′
4.	—— Concealed, (dip 6° to 8° for one mile,) say		500′
5.	Sandstone, gray,	25′	28
6.	Calcareous breccia,	3′	
7.	Sandstone, gray, (Sherwood's base of X,)		25′
8.	*Shale, red, &c.*, (Sherwood's top of IX.)		35′
9.	Sandstone, current-bedded, grayish green,		15′
10.	Shales,		5′
11.	Sandstone, current-bedded, thin layers,		40′
12.	—— Concealed, (probably shale,)		250′
13.	Sandstone, finely laminated, greenish gray,		30′
14.	—— Concealed,		50′
15.	Sandstene, current-bedded, greenish gray,		20′
16.	—— Concealed,		350′
17.	Red shale and sandstone,		35′
18.	*Fish Conglomerate,*		2′
19.	Red shale and sandstone,	visible	200′
20.	Concealed to *top of Chemung,*	possibly only	100′
	Total,*		2000′

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* This total is larger than that heretofore reported from the Tioga river. My measurements may be thus explained: Nos. 2 and 3 were directly measured across the beds.

From top of No. 4 at Blossburg to top of No. 5, near mouth of East creek, N. 30°, W. about 1 mile; rise nowhere less than 6°, often 8°; therefore 500′ is rather under than over the mark.

Messrs. Evans (quoted in H. G. Rogers' Geol. Pa., II, 520,) measured Umbral (XI) 238′+Vespertine (X) 150′=388′. This is *430′ less* than my 818′.

Nos. 5, 6, 7 and 8 are well exposed just opposite the mouth of East creek. Here the bottom of the Evans (Rogers') section, "30′ to 35′ red shale," is the same as my No. 8.

Nos. 9 to 20 were got by carefully following the steep rise of No. 8 northward, along the mountain side opposite Red Rock, and then making an almost vertical barometric leveling down to the noted *Holoptychius bed* (No. 18) on the railroad below.

No. 20 may be thicker than 100′, which would make the whole *red shale* (Nos. 19–20) 300′. Hall's N. Y. Fourth District report (1844) recites "400′" of red rocks in the Cattskill near Blossburg.

Mauch Chunk, XI, and *Pocono*, X, together,	818′
Catskill, IX,	1122′
From base of XII down to top of VIII in Tioga county,	1940′
" " " " *in Wayne county*,	2740′
Amount of thinning westward,	800′
Rate of thinning westward,*	10′ per mile.

CHAPTER VIII.

The Upper Chemung rocks.

These come to the surface no where in Wayne, and only along the State line belt in Susquehanna county. They are well exposed at the Falls of Cascade Creek in Harmony township, 2 miles N. E. of the mouth of Starucca Creek. The overlying *lower Catskill* measures are exposed near the mouth of Starucca Creek. The combined section is as follows: (See Fig. 10.)

Catskill.

1.	*New Milford lower sandstone*,			25′
2.	————concealed,	65′	*New Milford red shale* interval.	115′
3.	Sandstone, gray,	5′		
4.	Shale,	5′		
5.	Sandstone,	4′		
6.	Shales, sandy, gray,	6′		
7.	Sandstone, greenish-gray,	30′		
8.	Shales, olive, Starrucca,			105′
				245′

Chemung.

9.	Shale, olive, *with Chemung fossils*,		20′
10.	Sandstone, olive,		3′
11.	CONGLOMERATE *with* FLAT *pebbles*,		1′
12.	Sandstone, olive,		4′
13.	Shale, olive,		8′
14.	Sandstone, olive,		4′
15.	Shale, olive; *iron ore* near middle, 40′	*Mansfield reds*,	90′
16.	Shale, *brick-red*, 10′		
17.	Sandstone, shaly, green, 5′		
18.	Shale, soft, { upper, greenish, lower, dark, purple, } 20		
19.	Shale, olive, *spirifer bed, fish?* 15′		

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* Suppose this rate to be maintained still further, to Titusville, 140 miles west of Blossburg, the XII–VIII interval ought to be reduced at Titusville to (1940′—1400′) 540′ which approximates closely to observed facts.

20.	*Cascade sandstone*, (*Fall creek conglomerate**),	25′
21.	Shale and sandstone, olive, *very fossiliferous*,	30′
22.	Sandstone, brownish, *prismatic block fracture*,	25′
23.	Shale, bluish-olive,	25′
24.	Sandstone, brownish, *very fossiliferous*,	15′
25.	Shales, olive and flaggy, *quite fossiliferous*,	25′
	To bottom of Cascade exposure.	275′

The absence of red rocks in the New Milford lower shales at this locality shows how little we can rely on color for identification. Elsewhere in the county over 100′ of these shales are *red*. The few layers exposed in the concealed interval No. 2 are gray.

No *Chemung* shells appear above the 20′ olive shale deposit No. 9.

The *fossil shells* of No. 9 are principally *Spirifers and Rhynconellas* of Chemung type, but too badly preserved to determine their species.

The *flat pebbles* of No. 10, are of white quartz, and look like those of the *Venango Oil Sands.*

The *Mansfield iron ore bed?* (in No. 15) is lean, clayey, and full of fragments of *Spirifers* &c., in bad condition for specific determinaton.

A lower *Mansfield ore bed* is perhaps represented here by some iron-ore nodules in the 10′ brick-red shale (No. 16.)

The 15′ shale (No. 17) is quite full of *Chemung fossils*; one layer, just below the middle of it, is a mass of *Spirifers*, *&c.—S. disjuncta*, *Pterinea, sp?* *Streptorhynchus Chemungensis*, and many fragments of what seem to be *fish remains.*

Nos. 10 to 16 are exposed along the Jefferson branch railroad for 1,000 yards, from the Erie junction, up to Starucca Creek, beyond Jefferson junction. Hence, No. 16 (brick red) can easily be traced, along the Erie, railroad to Cascade Creek; and so the upper part of *the section* be tied to the lower.

The Cascade sandstone (No. 20) makes the fine cliffs which wall in Cascade Creek where the Erie railroad crosses it; is a rather coarse, very hard, yellow sand rock; is full of shells in its lower layers; and contains many fragments

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*Of Sherwoods' Bradford and Tioga Report G.

Blossburg Section.

Fig. 9a.

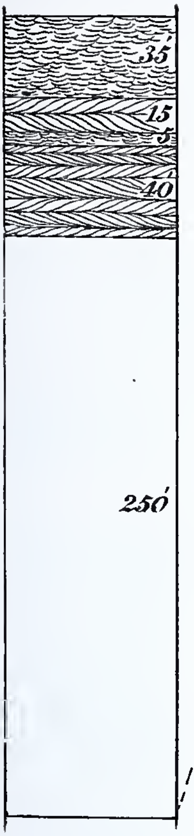


Fig. 9b

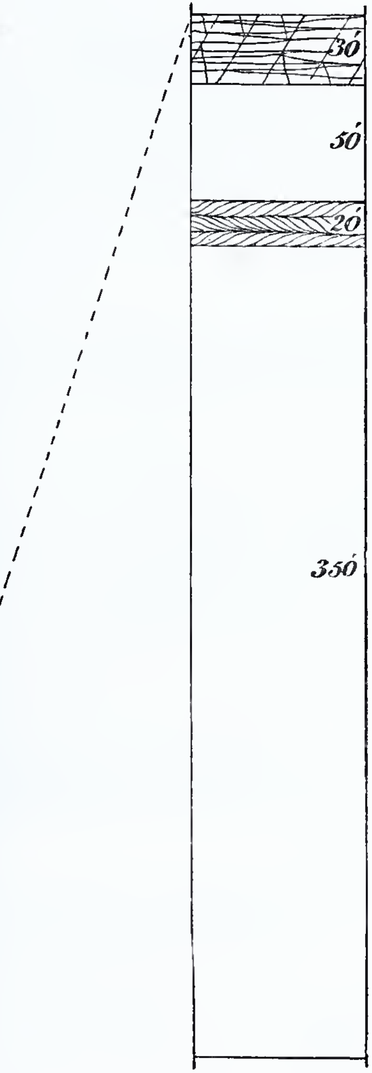
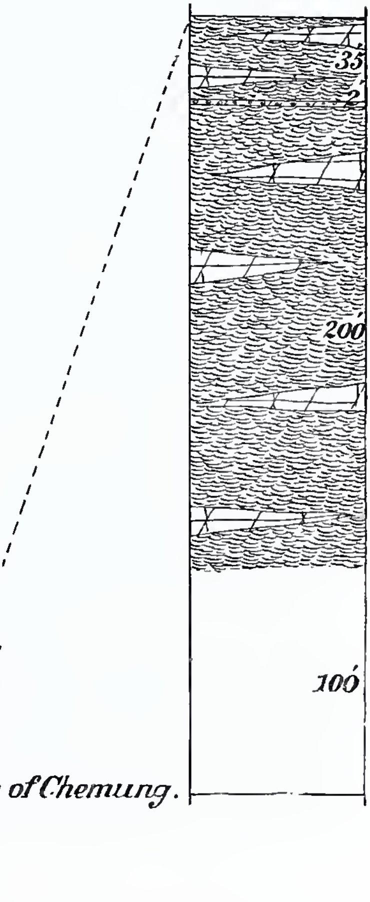


Fig. 9c.



To illustrate Report G^5 page 75.

of *coaly material derived from carbonized plants.* Its bottom layer is a perfect mass of *Rhynchonella contracta*, *Pterinea*, *Productella boydii*, *Spirifera disjuncta* and other less numerous shells.—Copperas incrustations of the exposed rock show the presence of *iron pyrites*, no doubt connected with the plant remains.

I identify this *Cascade sandstone* with Mr. Sherwood's *Fall Creek conglomerate*, because I have traced the *New Milford Lower sandstone*, by its current-bedded feature, to its unmistakable outcrop 325′ above the *Fall Creek conglomerate* at its type locality in Bradford county. My Cascade section makes the interval 350′ *

My section on Fall's Creek, Bradford county, is as follows: (Fig. 11.)

1.	*New Milford lower S.* current-bedded; *cliffs*,	10′
2.	——— concealed,	120′
3.	Shales and thin sands, *full of Chemung fossils*,	80′
4.	*Conglomerate*, blackish, quartz, pebbles,	2′
5.	Shales and flags, *very fossiliferous*, one or two *spirifer beds*,	120′
6.	*Fall's creek conglomerate*, Sherwood, *Cascade sandstone*, White, base,	20′
	Base of N 6. 1290′ A. T. (barom.),	352′

The thin *Conglomerate* 106′ above the *Cascade sandstone* (fig. 10) is curiously represented by a thin *conglomerate* 120′ above the *Fall's Creek conglomerate* (fig. 11), which helps to confirm my identification.

The stoppage of Chemung forms at 130′ above the *Cascade sandstone* (fig. 10), while they continue to be very abundant as high as 200′ above the *Fall's Creek conglomerate*, is no argument against the identification; for I cannot deny Mr. Sherwood's assertion that their upper limit

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* I have also found the *Fall's Creek conglomerate* outcrop just north of the N. W. corner of Susquehanna county, where it underlies the New Milford Sandstone about 350′. I count on the current-bedding for identifying the rock on Fall's Creek, because over a wide area of Susquehanna county I could find no current-bedded sands *below* the *New Milford lower sandstone*. But there is, moreover, no great difficulty in tracing the rock itself from its Susquehanna county areas through Bradford county to Fall Creek.

Upper Chemung rocks; two comparative sections obtained in Susquehanna and Bradford Cos.

Fig. 10.

Cascade. IX & VIII.

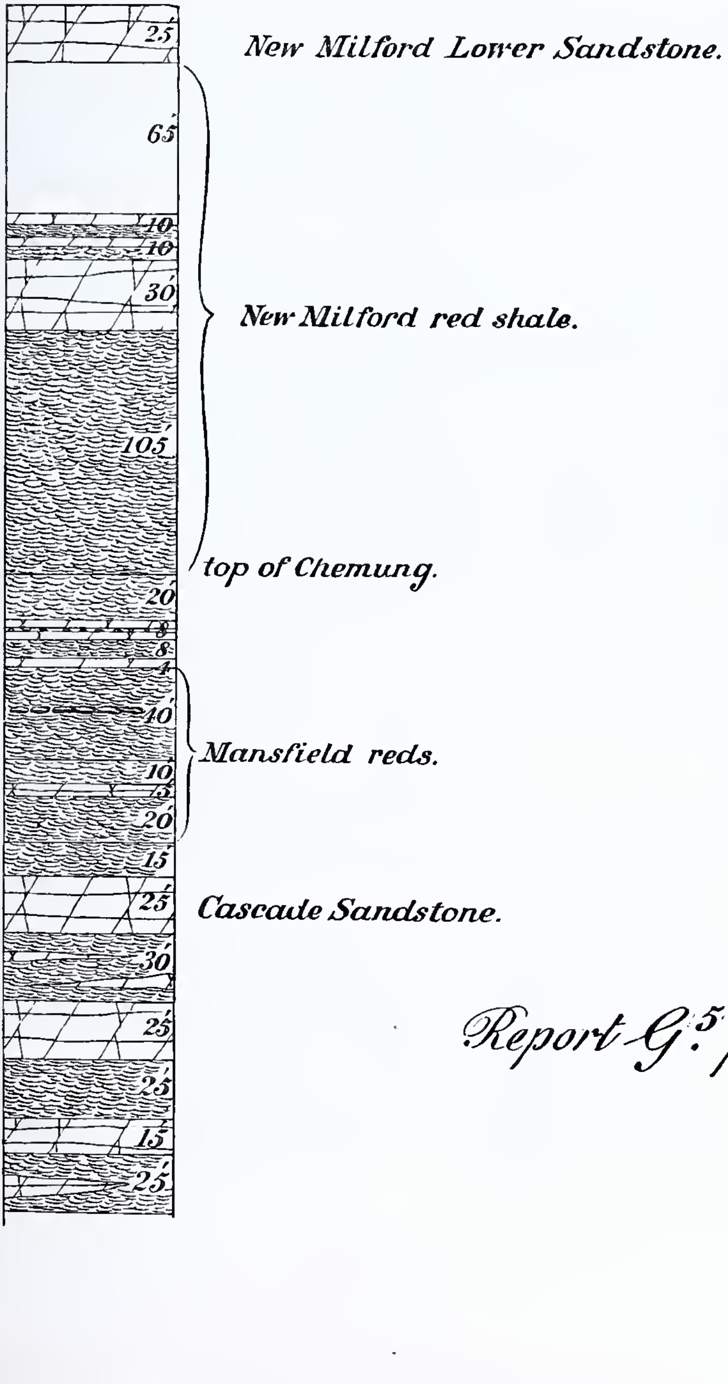
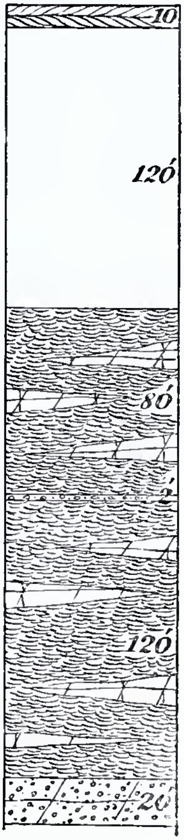


Fig. 11.

Falls Creek.



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rises westward, and may possibly, as he supposes, pass into and perhaps through the *Catskill*, into the *Pocono* formations; although I do not consider it by any means demonstrated.

Is the *Cascade sandstone* (*Fall's Creek Conglomerate*) the *Panama conglomerate* of Chautauqua county in western New York, as claimed by Mr. Sherwood, (See Report G,) and therefore, also, the *Third Sand of the Venango oil region?* (See my Report on Erie and Crawford counties, Q 4, 1881.)

The flattish shape of its pebbles is one argument in favor of this identification. A community of fossil forms is another. Its similar topographical features is a third. Its general relative situation in the column of rocks is a fourth.

To *prove* the identity, however, will require a slow, painstaking, continuous survey along the State line, chiefly through the lower tier of New York counties, for at least 150 miles.

But supposing the identification made—it then becomes probable, that—

1. *The thin conglomerate*, 110′ to 120′ above *the Cascade* (*Fall's creek, Panama, 3d Oil sand*) would very well represent the *2d Oil Sand.*
2. The *Mansfield reds* (beneath it) would represent the *Venango reds.*
3. The lower part of the *Venango group* would be of Chemung age, and the upper part of Catskill age.

Nos. 21 to 25 of the Cascade section (fig. 10) are well-known Chemung shaly and flaggy strata full of *Spirifera disjuncta*, *Spirifera mesacostalis*, *Rhynchonella contracta*, *Productella boydii*, and many other fossil shells which I could not certainly identify in the field.—*Crinoidal stems*, and their fragmentary discs, are very abundant in many of the layers.—Nearly all these rocks are of a dark brownish-olive color; and the layers of stone break into rudely prismatic blocks from 1′ to 2′ thick.

What is the chance of finding petroleum in Susquehanna and Wayne counties, by boring through the Catskill surface rocks, until the *Cascade sandstone* or other higher Chemung layers are reached?

This question, of so much practical interest to the inhabitants of the district, can only be answered by experiment; but it is evident that the rock outcrops corresponding to the oil-measures of the western counties show no signs of holding, or of ever having held, oil; therefore the *antecedent probability* is *against* their holding oil where they are buried deeply beneath the surface throughout the two counties.

The *Cascade rock*, for example, all along its outcrop, is a close-grained, compact stone, entirely unsuitable for oil wells. There is of course a *possibility* that, in its underground passage southeastward to rise in Pike county, it may change its character and become coarse and loose; but there is no way of finding this out except by drilling; and even if it does thus become a coarse conglomerate under southern Wayne county (as some of the Catskill rocks do) it may still be everywhere entirely destitute of oil.

Fig. 12.
Mrs Doyle's Section.

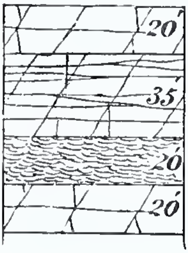


Fig. 14.
Folett's Ledge.

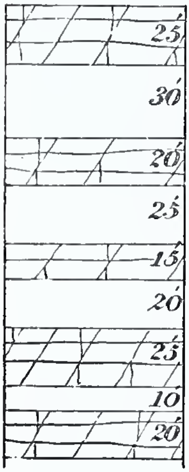


Fig. 16.
Great Bend
(2 m. abv.)

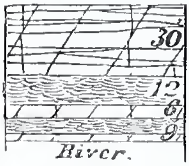


Fig. 13.

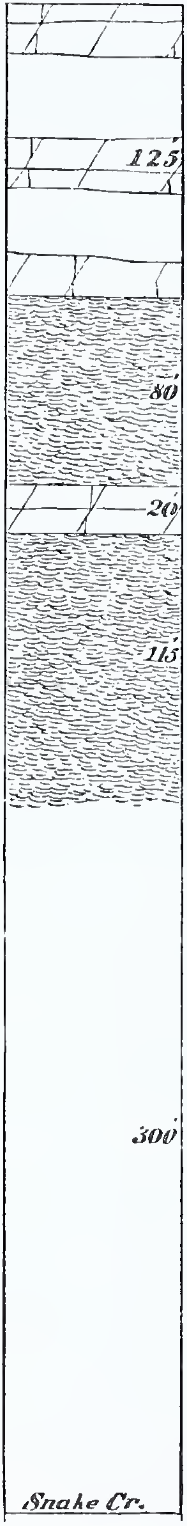
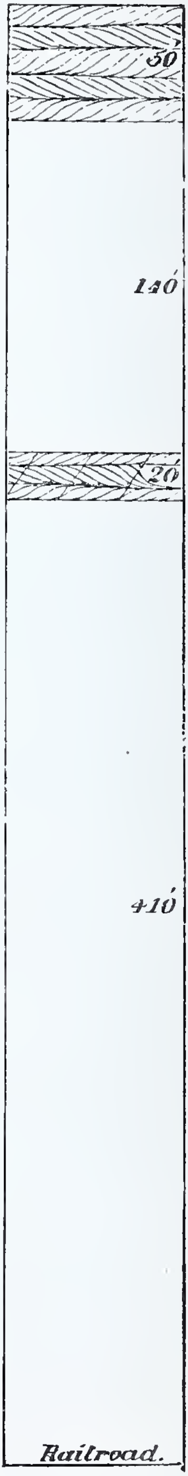


Fig 15.
Great Bend



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TOWNSHIP GEOLOGY.

CHAPTER IX.

DETAILED GEOLOGY OF SUSQUEHANNA COUNTY.

1. Apolacon, in Susquehanna County.

This township occupies the extreme northwestern corner of Susquehanna, and is almost a parallelogram in shape with the longer sides extending north and south.

It is drained chiefly by Apolacon creek, which rises on its eastern and northeastern border, flows northwest into the State of New York near the western line of the district, and keeping northward empties into the Susquehanna river. It is a very sluggish stream throughout the most of its course, as it is constantly bordered with banks of Drift which totally cover up and conceal the bed-rock.

Near the southern line of this area there is a low divide between the head-waters of the Apolacon and those streams which carry the drainage southward and southwestward into the Wyalusing; here the aspect of the country looks very much as though the northern ice sheet had cut down the divide to such an extent that the morainic drainage may have passed southward across it into the Wyalusing valley.

The whole area of the township is so sheeted with Drift that very little of its rock-structure can be seen at any point.

This is one of the few townships in Susquehanna in which the Drift is found to contain any bowlders of *granite* or *metamorphic rocks*. They are all small however and much water-worn, indicating transportation over a long interval. No *granite bowlders* were observed greater than two feet in diameter, and in the great majority of instances they do not exceed one foot.

Though the bed rock is thus almost universally concealed in Apolacon, yet a few of its highest ridges furnish rock exposures, and from these we learn that its highlands are capped with *Catskill* strata while *Chemung* outcrops line its valleys and hill sides.

About one and a half miles northwest from the borough of Friendship, we come to one of these high rounded knobs capped with the greenish gray sandstones of the *Catskill* which exhibit bold cliff out-crops at 1700′ A. T. and also continue making cliffs at short intervals up to the summit at 1825′. The surface of the ground on the southern slope of the hill is strewn with large blocks of *Catskill sandstone* from top to bottom.

The *base of the Catskill sandstone series* is seen at 1700′ A. T. in the western portion of the township, near J. Kiley's, and there many detached masses of rock occur as well as the out-cropping cliffs of the same. The base of the *Catskill measures* would then occur here at 1500′ above tide; and as the elevation of the Apolacon valley where it passes out of the township to the north is about 1050′, the *Chemung rocks* would line the hill slopes for about 400′ above; though none of the strata can be seen, for the deep coating of Drift and debris.

Catskill cliff sandstones are also seen capping the summits of hills near the eastern line of the township.

The *Chemung or Fall Creek conglomerate* (*3rd Oil Sand?*) of Sherwood's Bradford Co. section is seen about 1½ miles from the northwest corner of Susquehanna Co. just over the N. Y. line. The blocks of *conglomerate* covering the ground at this horizon (1650′ A. T.) are filled with flat quartz pebbles, and the matrix is a coarse dark sand.

The crest of the *Blossburg axis* occurs not far from the outcrop of the *conglomerate* and it is the passage of this axis near the N. W. corner of the county which brings up the *Chemung rocks* to so much greater an elevation than we find them along the Susquehanna river further east in the vicinity of Great Bend.

Barometric elevations in Apolacon.

	A. T.
Level of Apolacon at Little Meadows P. O., ...	1050′
Cross roads just south, ...	1075′

Forks of road at A. Graves',	1120′
Forks at School House No. 3,	1180′
" near Wm. Creagh's,	1650′
" " P. Ryan's,	1650′
" " Mrs. Lynch's,	1560′
" " S. F. Carmalt's,	1470′
" next N. W.,	1200′
Cross roads near D. Sheahen's,	1300′
Forks west from J. Foster's,	1725′
" near R. Bowen's,	1650′
Level of Lake of Meadows,	1550′
Forks near P. McVinnie's,	1500′
Cross roads near L. Hickey's,	1550′

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2. *Choconut, in Susquehanna county.*

This lies directly east from Apolacon and like it borders on the N. Y. State line.

It is drained entirely by the waters of the Choconut creek, a very sluggish stream which rises just south of the township line, and flowing northward along its eastern limit, empties into the Susquehanna river within the State of New York.

The township is a small one, and its surface is so buried by Drift and loose material that very few exposures can be seen.

Catskill rocks underlie all the higher areas, while the valley of the Choconut and the adjacent hill sides, up to 100′—200′ above, consist of *Chemung;* though these lower beds are seldom or never uncovered.

Section at Doyle's.—On the land of Mrs. Doyle, near the western line of the township the following succession is seen at the roadside : (Fig. 12.)

Mrs. Doyle's section.

1. Massive greenish gray sandstone,	20′
2. Shaly sandstone,	35′
3. Red shale,	20′
4. Massive green sandstone, (base 1650′ A. T.,)	20′

It is needless to say that this succession belongs in the *Catskill* series, since no where in the *Chemung* do we find beds of sandstone at all resembling Nos. 1 and 4. Seen in cliffs they have a very solid massive appearance, but on closer examination they are found to be rather finely laminated, the layers varying from ⅛″ up to 3″ in thickness, of a greenish blue or gray color, totally non-fossiliferous, except occasional plant remains, and very remarkably current bedded; this feature alone serving to distinguish them sharply from all other rocks in the *Chemung or Portage* below.

The base of this section comes about 200′ above the top of the *Chemung* and therefore the sandrocks come within the *New Milford group.*

Along Choconut creek and over the highlands, up to 1750′ above tide, we find many small *bowlders of metamorphic rocks* in the Drift, all well rounded and worn by attrition.

Barometric elevations in Choconut.

	A. T.
Level of Choconut creek near M. J. Donnelly's,	1120′
Forks of road near E. Burke's,	1160′
" " " J. Stanley's,	1375′
Borough of Friendship, (summit,)	1550′

3. Silver Lake, in Susquehanna county.

This lies immediately east from Choconut and has New York for its north boundary. The drainage goes in almost every direction; that from the western border passing into Choconut creek; the southern and central being carried off southward by Silver creek; while that from the east and north goes east into Snake creek.

One peculiarity which this township shares in common with many other areas in both Susquehanna and Wayne, is the occurrence of several small lakes; among which are *Quaker*, *Silver*, *Cranberry*, *Mud*, and several others that have not received names. Quaker is the largest, containing something over 100 acres in area, well stocked with fish, and is quite a noted summer resort for Binghamton and other towns in the vicinity. Silver Lake is also much visited by sportsmen and tourists. All of them are of Glacial origin as has already been explained in a previous chapter.

The rocks belong to the *Catskill*, with possibly a few small areas where the streams have trenched through them into the top of the *Chemung*, in the extreme northern portion; but even if any such patches exist above drainage they are very small and of no importance.

The massive *cliff sandstones* of the *Catskill* are seen extending in long lines of vertical walls around the sides and summits of many hills. One at about 600′ above the base of the Catskill is especially massive. This is seen capping the hill at the eastern line of the township near Mr. Maroney's at an elevation of 1795′ A. T.

Descending to a tributary of Silver creek from that point, several outcrops of massive sandrocks are seen, and we come down to the base of the *Catskill sandstones* at 400′ below or 1395′ A. T. At 1495′ a very massive stratum of greenish gray sandstone is seen forming a line of broken vertical cliffs around the hills.

Just north of Silver Lake a cliff sandstone is seen in the summit of the hills 175′ above the level of the lake, and 1825′ A. T.; it is most probably the same stratum as that seen at Maroney's.

About one and a half miles south of Mud Lake, on the land of Mr. M. Hill, a massive sandstone is seen outcropping at 1480′ A. T. and this is most probably the one which occurs at Maroney's 100′ above the base of the *Catskill sandstone group.*

Just north of Quaker Lake and 150′ above the level of the same, another massive sandstone is seen at 1600′ above tide.

At the western line of this township, near J. O. Shay's a massive sandrock is seen capping the hills at 1700′, and below it come 100′ of *red shale.*

Barometric elevations in Silver Lake.

	A. T.
Level of Quaker Lake,	1450′
" Silver "	1650′
" Mud "	1550′
" Silver creek at H. Snow's,	1250′
Forks at J. Shay's	1415′
" near M. Hill's,	1475′
" " A. B. Hill's,	1650′
" " D. Maroney's,	1695′
" " T. Roger's,	1560′

Fork near J. Ward's,	1660
" " School House No. 5,	1580′
" next north,	1520′
" near M. Laughlin's,	1490′
" next north,	1490′
" north of J. Johnston's,	1470′
" near P. Powers',	1460′
" " D. Nolan's,	1470′
" " J. Gage's,	1710′
" " B. Whiting's,	1530′
" " J. Hayes',	1700′
" " A. J. Sheldon's,	1720′

4. Liberty, in Susquehanna county.

This lies directly east from Silver Lake, having New York on the north and Franklin township at the south.

It is a nearly rectangular area, and is drained almost entirely by the waters of Snake creek, which enters it from Franklin at the south, and flows northeast into the Susquehanna river just north from the eastern line of the township.

The rocks of this area belong entirely to the *lower portion* of the *Catskill*, with the single exception of the valley of Snake creek, where erosion has cut down to the *top* of the *Chemung* for a considerable portion of its course.

The massive sandstones of the Catskill make many ledges and cliffs in various portions of this township.

In descending the hill road from the summit at R. Dingman's the following exposure occurs: (Fig. 13.)

Dingman's section.

1. Massive sandstone in several beds,	125′
2. Red shale,	80′
3. Massive sandstone, (*New Milford Lower*,)	20′
4. *Red shale*, (*New Milford*,) visible,	115′
5. Concealed to level of Snake creek (1000′ A. T.,)	300′

No. 3 is the lowest member of the *Catskill sandstone series* and is seen as a greenish gray, much current-bedded sandstone, jutting out of the hill almost constantly, and always making a steep bluff even when it does not form a cliff. It is of tolerably fine grain, and usually thinly laminated.

The *Chemung rocks* come in about 100′ below the base of the *115′ red shale* and hence line the valley of Snake creek at this point and the side hills for 200′ up.

Nos. 1–3 represent the lower half of the *New Milford sandstone group*, and the members of No. 1 are quite massive, about 20′ feet thick each, separated by shale.

Just north from the top of this exposure, a great gap is cut out of the dividing ridge between the waters of Rhiney creek and a tributary of Snake creek. The *cut-out* extends down 200′ below the adjacent hills.

No. 4 is the lowest exposed portion of the *Catskill red shale*, and is almost blood red; occasional layers of more sandy material alternate with the shale.

Passing west from the locality of the last section we come to a long line of gray sandstone cliffs at 250′ above No. 1, or 1890′ A. T.

Near the western line of this township, is a small oval body of water called *Tripp lake;* it covers about five acres of ground, and has an average depth of 50′ off the shore line, though in the deepest portions it attains as much as 80′. The lake is surrounded by morainic débris and is doubtless of glacial origin.

At the forks of the road, on the Hanigan estate, one mile northwest from Tripp lake, the outcrop of a massive sandstone is seen at 1500′ above tide; its place is in the *New Milford sandstone group.*

Barometric elevations in Liberty.

	A. T.
Cross roads at Lawrenceville Centre,	1085′
Forks near W. Barrey's school house,	1550′
Level of Tripp lake,	1420′
Forks near west end of Tripp lake,	1695′
" Hanigan's est.,	1475′
" R. Dingman's,	1385′
" J. L. Butler's,	1100′
" C. Stanford's,	1075′

5. Franklin, in Susquehanna county.

This lies directly south from Liberty, having Silver Lake and Bridgewater townships for its western boundary, while Great Bend and New Milford surround it on the east.

It is drained principally by the waters of Snake creek which rises at its southern central line, and flows northward into Liberty.

The rocks of this area belong to the *Catskill* with the exception of a narrow trench cut into the *top* of the *Chemung* along the lower waters of Snake creek.

There is not much of interest to be seen anywhere in this area, the only rocks exposed being those of the *Catskill sandstone series* which occur to the westward in Silver Lake and other townships. These are often seen jutting out of the steep hillsides in bold cliffs, or covering the surface with piles of débris.

Just north from C. Folett's, a great ledge of greenish-gray sandstone outcrops at 1750′ A. T.

Just north of the same locality, another massive sandstone is seen in the hill with its base at 1700′ A. T., and in descending from this point westward the following succession appears: (Fig. 14.)

Folett's ledge section.

Gray sandstone,	25′
Concealed,	30′
Gray sandstone,	20′
Concealed,	25′
Gray sandstone,	15′
Concealed,	20′
Gray sandstone,	25′
Concealed,	10′
Gray sandstone, (base at 1585′ A. T.),	20′

These sandstones succeed each other in cliffs, just like huge stepping stones, only the horizontal distance between them is irregular. All have about the same physical appearance, being current-bedded, laminated, and grayish-green in color. The concealed spaces are most probably occupied by *red shales*, since that kind of material is seen at the same horizons in the adjoining township.

About two miles west from this where the road crosses the run near B. J. Baker's, the *New Milford Lower sandstone* is seen in the hill at 1350′ A. T.

On the summit of the hill, near A. Townsend's, a massive sandstone begins at 1725′ and extends up to 1775′ A. T. It is the same as the top stratum of preceding section. Below it at 1710′ a *blood-red shale* is seen.

Near Upsonville, at the northern line of the township a very *red shale* is seen at 1650′ A. T. and is exposed along the road in a thickness of 30′. The same shale also makes a *red band* in the road, for a considerable distance, at the Presbyterian church, one half mile south from Upsonville:

Barometric elevations in Franklin.

	A. T.
Forks near C. Folett's,	1665′
" M. S. Brundagee's,	1660′
" N. T. Buck's,	1575′
" School-house No. 9,	1475′
Cross rords near J. M. Baker's,	1225′
Forks near school-house No. 8,	1215′
" S. P. Halsey's,	1165′
Level of Snake creek at Franklin Forks,	1085′
Forks near B. R. Todd's,	1125′
" N. P. Wheaton's,	1225′
" D. Salsbury's,	1545′
" next east,	1665′
Cross roads in Upsonville,	1620′
" at school-house No. 2,	1505′
Forks near E. S. Looker's,	1700′
" school-house No. 7,	1425′

6. *Great Bend, in Susquehanna county.*

This lie immediately west from Liberty and has New York for its northern boundary.

The Susquehanna river passes entirely across its area, entering it near the middle of its eastern line, and leaving it at its northwestern corner, receiving the entire drainage of the township direct from the tributary streams both north and south.

The rocks of this township belong to the *Catskill* and *Chemung*. The *Catskill measures* cap all the summits of the hills, while a broad band of *Chemung* lines the valley of the Susquehanna and all its tributaries for some distance from their mouths. The base of the *Catskill sandstone* *series* is seen at many places along both banks of the Susquehanna river, where a massive sandstone, much current-bedded, is seen jutting out of the hillsides in long lines of cliffs 425′ to 450′ above the stream.

These cliffs are especially prominent along either side of Salt Lick creek; and one of the outcrops may be seen opposite McKinney's school-house, two miles south from Great Bend village, where the following was obtained in descending the hill on the left branch of the stream: (Fig. 15).

Great Bend section.

1.	Gray, current-bedded sandstone, (top 1505′ A. T.),	50'
2.	—— Concealed,	140′
3.	Gray, current-bedded sandstone,	20′
4.	Concealed to level of Great Bend depot,	410′

No. 1 extends to the summit of the hill, and its slopes are strewn with large fragments broken away from it. The stratum is greenish-gray, with the layers 1 to 2 inches thick, rather finely grained, and beautifully current-bedded.

In No. 2 come three or four beds of sandstone; but they are all concealed at this locality.

No. 3 is the *New Milford Lower sandstone*, being the first stratum that makes a cliff in the hills as we pass upward from the base of the *Catskill;* hence it becomes a well marked horizon, especially along the Susquehanna.

No exposures are to be seen in No. 4 at this locality; but the gently rounded topography of the hill-slopes would lead to the conclusion that it contains nothing except soft shales or easily disintegrating flaggy sandstone.

About one mile and a half south from the last locality the *New Milford lower sandstone* is seen in a long line of outcrop, passing around the hills with its base at an elevation of 1175′ A. T. or 120′ lower than at the school-house, thus giving a dip in this interval of 80′ per mile. This is however merely local; since northward from the school-house it is almost horizontal, as well as southward from the same locality. The stratum is 20′ thick and much current-bedded.

On the opposite side of the stream, it and other sandstones above, are seen jutting out in cliffs far up the hill.

About one half mile southeast from Great Bend depot this same *New Milford lower sandstone* is seen putting out of the hill in a bold cliff, and forming a lofty prominence 450′ above the level of the Susquehanna; a magnificent view of the Susquehanna valley is obtained from this position, and the locality has been named by the inhabitants "Fort '76."

The cliff has an elevation at base of 405′ above Great Bend depot (884′,) and being 25′ in vertical height is 1314′ A. T. at top.

Great Bend Limestone.—Passing down to the Susquehanna river we find a thin *calcareous layer* filled with *Chemung shells* at 400′ below the base of the "Fort '76" cliff or *New Milford lower sandstone.* The layer varies from ½′ to 2′ in thickness and sometimes disappears entirely. It occurs on the land of Mr. Lusk, about 20′ above the level of the Susquehanna. Immediately below the *shell rock* come finely laminated shales, on which the *calcareous layer* appears to rest uncomformably in some places, through local causes doubtless. Below these shales come sandy layers containing nuggets of siliceous *iron ore*, of various sizes from one inch to a foot and a half in diameter. In the *calcareous layer* were seen *Streptorhynchus Chemungensis*, *Spirifera disjuncta*, *Rhynchonella contracta*, *Leiorhynchus Newberrii*, together with many other indeterminable forms of well known *Chemung facies.*

About two miles above Great Bend depot the Susquehanna river flows through a narrow gorge, only 100 yards wide, where it is hemmed in by vertical walls of outcropping strata. The following section was obtained on its left at this locality: (Fig. 16.)

Two miles above Great Bend.

1. Flaggy sandstone,	30′
2. Shales,	12′
3. Sandstone,	6′
4. Blue shale,	6′
5. Flaggy sandstone to river level,	3

About midway in No. 1 is a bed of shale 5′ thick, and, it, as also No. 2, contains many *iron concretions.*

Indian pictures.—This locality is often termed "Red

Rock" from the fact that on the face of the sandstone stratum No. 3, which juts out boldly along the river, the Indians have painted figures in red.

On the opposite side of the river, in a cut along the Erie R.R., we see 5′ more of flaggy sandstone above the top of No. 1 and then above that come 30′ of olive shales to top of bluff.

Limestone.—Here along the R.R. is seen the *impure limestone* seen one mile below, and it can be traced constantly in the cuttings of the R.R. nearly to Great Bend. Opposite the gorge it comes 30′ above the level of the river showing a slight rise in the strata as we go eastward from Great Bend Depot.

About one mile below "Red Rock," on a small stream which puts into the right bank of the Susquehanna, there is a flagstone quarry at the horizon of the *Great Bend limestone*, and some very nice flags are obtained and used in the construction of sidewalks.

A short distance northeast from Great Bend Depot, and 1½ miles in a direct line from "Fort '76" cliff the following section was made by Prof. Richardson of the Great Bend Graded School, and kindly placed at my disposal : (Fig. 17.)

Hinkerma ledge section.

1.	Massive, gray sandstone, ("Hinkerma ledge,")	30′
2.	—— Concealed,	60′
3.	Sandstone,	5
4.	—— Concealed,	50′
5.	Sandstone,	5′
6.	—— Concealed,	40′
7.	Sandstone,	5′
8.	—— Concealed,	50′
9.	Sandstone,	8
10.	—— Concealed,	15′
11.	Sandstone,	6′
12.	—— Concealed,	80′
13.	Sandstone, (*New Milford lower*),	10′
14.	—— Concealed,	145′
15.	Olive shales,	10′
16.	—— Concealed to level of the Susquehanna,	245′

The series of sandstones Nos. 1 to 13 inclusive represent the *New Milford group.* Its average thickness is about

350′ from the base of No. 13, the lowest member, up to the base of No. 1 the highest.

No. 1 sandstone is always quite massive and usually much coarser than any other member of the group.

The base of the group, No. 13, comes 380′ above the level of Great Bend station (884′) or 25′ lower than the base of the same stratum at the "Fort '76" cliff, one mile and a half southwest. This shows a slight reversal of dip toward the north.

A low anticlinal axis therefore crosses the Susquehanna near Great Bend.

At the horizon of No. 15 an opening has been made for *flagstone* in a field just north from Great Bend. The layers were quite thin and shaly however, and of a brownish or olive color.

The valley of the Susquehanna in this township is filled with moraïnic material and is from 1½ to 2 miles in breadth; the Drift seems to be all of local origin since no bowlders of *granite* or any *metamorphic rocks* are to be seen.

The appearance of the Susquehanna valley is such as to indicate the presence of an old buried channel of considerable depth, since in places it flows over a Drift-covered bottom; but as far as I could learn no explorations have ever been made that would test the matter. It is true that at some localities the bed of the river is now paved with rocky strata, as may be seen between the walls of its gorge at "Red rock" but this is evidently a new cut, since the ancient channel of the stream may now be seen one half mile further south, filled with Drift which silted it up during the Glacial Epoch; thus it is possible that in all cases where a rock bottom is now seen in the Susquehanna it is not flowing over the ancient or pre-glacial channel.

The *Chemung rocks* which line the valley of the Susquehanna, as well as those of the *Lower Catskill* above them, contain considerable quantities of *binoxide of manganese* disseminated in small particles; and in some instances it has been carried down into the bogs and deposited in the shape of *wad;* at one of these localities near Great Bend, several tons of this material were once mined and shipped on the Erie R.R.

7. Oakland, in Susquehanna county.

This lies directly east from Great Bend and has New York for its northern boundary.

It is drained by the Susquehanna and its tributaries. The former stream enters the State, and the county, at the eastern line of the township, flows southward to Lanesboro, then veering west, passes across the central line of the township, cutting its area into two nearly equal portions, one north, the other south of the river.

This township is celebrated in history as having been the residence of Joseph Smith of Mormon fame, and in its northern portion the foundation walls of the first Mormon Temple may still be seen.

Glacial débris is seen in very extensive deposits all along Susquehanna in this township being often apparently piled up in long ridges or heaps parallel with the river, and sloping both ways from the sharp summits; so far as I could discover however no bowlders of *granite* or *crystalline rocks* exist in this morainic material.

These *drift* ridges are probably *Kames.*

The rocks, like those of Great Bend, belong principally to the *Catskill*, while *Chemung* is found along the sides and valley of the Susquehanna river, and for short distances up the channel of its tributary streams. These latter rocks are exposed along the cuts of the N. Y., L. E. & W. R.R. in the vicinity of Susquehanna Depot quite fossiliferous.

Near the coal chutes above this town a layer of rock is seen along the R.R. in which occur great numbers of *Rynchonella contracta*, *Spirifera disjuncta* and many other forms.

The top of the Chemung is found at about 180′–200′ above the level of the Susquehanna river; above this the shales and transition rocks of the *lower Catskill* extend to 380′–400′. Here the basal member of the *Catskill sandstone se-*

ries comes into the section and skirts the hills with a very bold outcrop on the south side of the river, and is often seen jutting out far up the slopes in a line of massive cliffs.

In the steep bluff, about one mile and a half below Susquehanna Depot, the following section was obtained in descending the hill on the left bank of the river: (Fig. 18.)

Susquehanna Depot lower section.

1. Massive sandstone,	12′
2. Shales, grayish, sandy,	30′
3. Massive sandstone,	35′
4. —— Concealed,	70′
5. Massive sandstone, (*New Milford Lower,*) 1250′ A. T.,)	10′
6. —— Concealed to level of the river,	380′

Nos. 1 to 5 represent the lower half of the *New Milford sandstone group*, and the base of No. 5 has an elevation of 1250′ above tide.

All of these sandstones are of a greenish-gray color, and much current bedded; large blocks of the same lie strewn over the hillside almost from top to bottom.

A very *red shale*, 10′ thick is seen along the road a short distance below Susquehanna Depot and 275′ below the base of the *New Milford Lower sandstone.* This is about 75′ below the top of the *Chemung*, and very possibly represents the *Mansfield iron ore horizon*; since a short distance above Susquehanna, and along the Erie R.R. many *nodules of iron ore* are seen which have come down from the bluff above out of this same horizon.

About one fourth mile above Susquehanna Depot, the following section is seen in a cutting along the Erie RR.: (Fig. 19.)

Susquehanna Depot upper section.

1. Somewhat massive sandstone,	10′
2. Shales,	4′
3. Sandy shales, olive,	8′
4. Reddish shales with *iron ore,*	10′
5. Flaggy sandstones to track, *fossiliferous,*	10′

This series is in the top of the *Chemung* and in No. 5 are seen many specimens of *Rhychonella contracta.* The bottom of this stratum comes at 940′ A. T. and it is probably the same fossiliferous horizon that is seen at Red Rock in Great Bend.

In No. 4 are many nodules of iron ore in kidney-shaped masses. Just on top of No. 1 comes 10′ of *brick red shale* which is the same as that referred to above as occurring below Susquehanna.

8. *Harmony, in Susquehanna county.*

This occupies the extreme northeast corner of Susquehanna county, being bounded on the north by New York and east by Wayne county.

The Susquehanna river flows along its western border from the northern State line until it reaches its central line when it turns off westward into Oakland. The river therefore receives all the drainage, principally through two streams—Starrucca and Canawacta creeks.

The rocks of this area belong to the *Chemung* and *Catskill*, the former occurring only along the Susquehanna river and the lower portions of Starrucca and Canawacta creeks.

☞ In this township lower *Chemung rocks* are seen than at any other locality in the two counties, and the *transition rocks* between the *Chemung* and *Catskill* are perfectly exposed.

Just opposite the junction of the Jefferson Branch of the Erie R.R. with the main line, two miles from Susquehanna Depot, the *New Milford lower sandstone* is seen jutting out of the hill on the left bank of the Susquehanna river at 1300′ A. T. or 50′ higher than the same stratum $3\frac{1}{2}$ miles further down the river in Oakland township. The rock is 20′ thick, and its base comes 300′ above the upper *red shale* band in the Chemung seen along the R.R. below.

As we pass up Starrucca creek eastward the rocks dip rapidly down, so that when we come to Steven's Point, $1\frac{3}{4}$ miles from Jefferson Junction or $4\frac{1}{2}$ miles from Susquehanna Depot, the base of the *New Milford lower sandstone* is found 225′ lower than it is opposite Starrucca bridge, *i. e.* only 1075′ above tide. In descending from that locality along Starrucca creek the following section was compiled: (Fig. 20.)

Starucca Creek section.

1.	*New Milford Lower sandstone,*	25′
2.	—— Concealed,	65′
3.	Sandstone,	5′
4.	Gray shales,	5′
5.	Sandstone, gray,	4′
6.	Gray sandy shales,	6′
7.	Somewhat massive sandstone,	30′
8.	Olive shales with *Chemung shells near base,*	125′
9.	Olive sandstone with a layer of quartz conglomerate near middle 1′ thick,	8′
10.	Olive shale,	8′
11.	Olive sandstone,	4′
12.	Olive shale with a layer of *iron ore* near the middle,	40′
13.	*Brick red shale,*	10′
14.	—— Concealed to Susquehanna river and containing the *Cascade Creek sandstone* near its center, . . . about	100′

No. 1 has been quarried quite extensively just below Steven's Point, and used in constructing the piers of bridges along the Jefferson Branch R.R.; is of a bluish green color, very hard and contains much olive shale in small fragments scattered through the coarser portions of the stone.

In No. 2 should be found a considerable quantity of red shale, but as it is all concealed nothing certain is known concerning its character.

Nos. 3–7 of the above section are seen at the narrows, one mile below Stevens' Point, where the creek having left its ancient channel has cut a new one between vertical walls of No. 7, in a cañon-like gorge.

Clay moraine and new channel.—The reason of the new cut is obvious, for just north of the present channel we find 75′ of a tough impervious reddish drab clay dumped down right across the old channel, and it was doubtless the cause of the change in the creek's course. The clay doubtless owes its origin to Glacial agencies; it is now manufactured into brick, is quite fine and homogeneous, not a pebble or bowlder of any kind being seen in the 40′ exposed in the R.R. cut.

No. 7 lies in rather massive layers and has been quarried to some extent near the chair factory; has a dark olive color, and exhibits no current-bedding, so common in No. 1 and the Catskill sandstones above.

Chemung shells are seen in the basal portions of No 8, and it may be regarded as the dividing line at this locality between the *Chemung* and *Catskill.*

No. 9 consists of layers of olive sandstone separated by shales and near its center is a layer of *conglomerate* one foot thick filled with *flat quartz pebbles.*

In No. 12 are also seen many *Chemung shells*, and a thin layer of lean *iron ore* comes near its center. This represents one of the *Mansfield iron ores* of Tioga county which hold their places with such remarkable persistency over widely separated areas.

No. 13 is a very red stratum of fine shale and is constantly seen from below Susquehanna Depot nearly to Jefferson Junction, just below which it passes beneath the drainage. It also very probably represents one of the *Mansfield red beds* or *iron ore horizons.*

Near the center of No. 14 down under the Erie R. R. bridge across Canawacta creek we see the outcrop of a coarse yellowish-white sandstone. It is not very well exposed however, and its thickness could not be ascertained. This is the same stratum which two miles further northeast makes a bold cliff along the banks of Cascade creek, where the Erie R. R. crosses that stream.

As we go northward from this point to Cascade creek, the rocks rise just about as fast as the R. R. grade, so that the *red band of shale* No. 13 is often seen in the cuttings.

Where the Erie R. R. crosses Cascade creek the stream has cut a deep and narrow cañon down through the upper portion of the *Chemung* and descending from the R. R. fill the following is seen: (Fig. 21.)

Cascade section.

1. Shaly sandstone,	10′
2. *Red shale,*	10′
3. Green, shaly sandstone,	6′
4. Soft, red shale, greenish at top,	20′
5. Olive, fossiliferous shale,	15′
6. Massive, yellowish-white S. S., (*Fall creek cong.*),	25′
7. Olive shale and sandstone fossiliferous,	30′
8. Brownish sandstone, breaking in prismatic blocks,	25′
9. Bluish, olive shales,	25′

Fig. 17.
Hinkermer ledge.

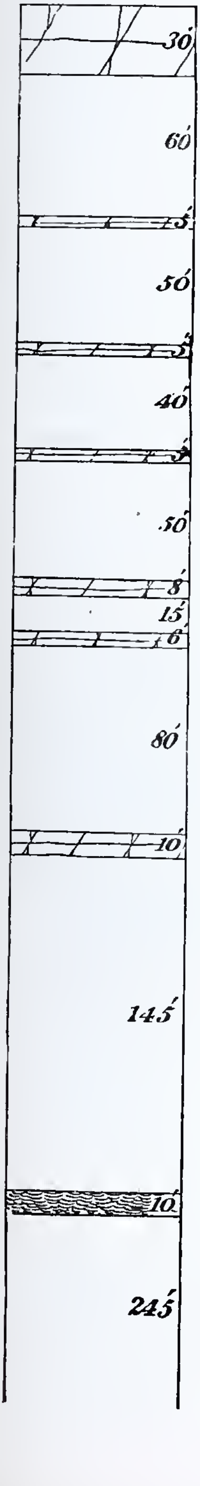


Fig. 18.
Oakland

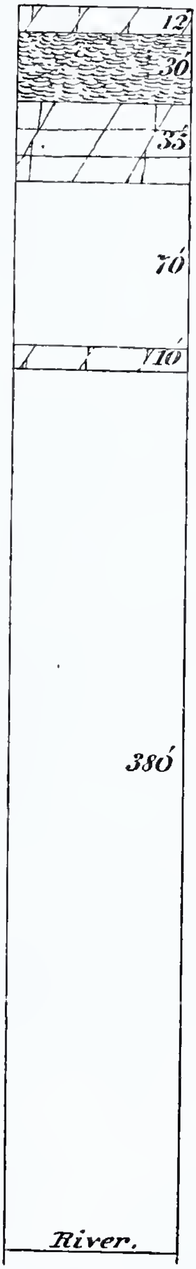


Fig. 19.

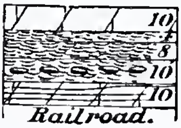


Fig. 20.
Starucca Cr.

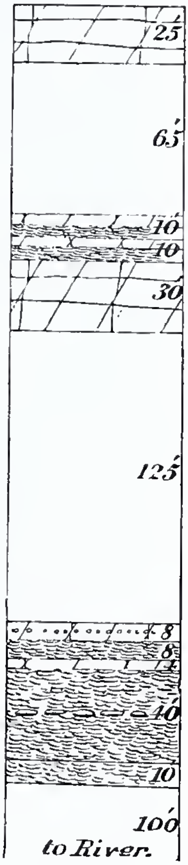
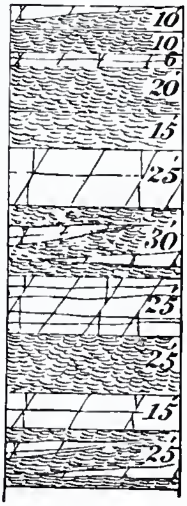


Fig. 21.
Cascade.



G5.

10. Brownish sandstone, very fossiliferous, ... 15′
11. Olive shales and flaggy sandstone to bottom of exposure all very fossiliferous, ... 25′

No. 2 is the same as 13 of the previous section, and comes here at an elevation of 220′ above the level of Susquehanna Depot, or (914+220) 1134′ above tide, nearly 150′ higher than where it occurs at Lanesboro' 2½ miles south.

No. 4 is a brownish-red, and dark olive-brown shale, very finely laminated, fissile, and weathering down to a common level on the exposure just north of the R.R.

About 3′ above the base of No. 5 is a conglomerate or brecciated mass of *shells*, *fishbones*, *pebbles of shale* and *sandstone*, all cemented into a mass of calcareo-siliceous material ; it most probably represents one of the *Chemung fish beds* of which Mr. Sherwood speaks in his report on Bradford and Tioga.

Plant bed.—No. 6 is finely exposed here, making a very bold outcrop around the sides of the gorge, a very coarse, massive, yellowish-white sandstone, and contains immense quantities of vegetable fragments, mostly carbonized and coaly specimens of limbs and branches, none of which can be referred to their *genera* or even *orders* for that matter. The lower portion of the rock also contains multitudes of shells, principally *Spirifers* and *Rhynchonellas*, all of *Chemung type.* The stratum also contains a considerable quantity of *Pyrite*, since the lower portion of the exposed face is frosted over with yellowish looking copperas.

This member of the *Chemung* comes about 350′ below the base of the *New Milford Lower sandstone* or 130′ below the top of the *Chemung.* I have traced the same *Catskill sandstone rocks* through to Bradford county, and there find the *Fall creek conglomerate* of Sherwood coming 325′ below the same *New Milford Lower sandstone.* This taken in connection with the fact that *a massive sandstone* or *conglomerate* is found in several intermediate places at the same horizon, renders the proof positive that the *Cascade creek S. S.* and *Fall creek conglomerate* are identical. As already stated, I believe them identical with the *Panama conglomerate* and *3rd Oil Sand* of Venango. In this I agree with the conclusion to which Mr. Sherwood arrived many years ago with regard to the identity of the *Fall creek* and *Panama conglomerate.* Mr. Sherwood claims to have traced the horizon through. But I rely for my determination on the peculiar lithological composition which is the same in each, on the similar associated fossils, and also on the parallel horizons of each, viz: about 130′ below the top of the *Chemung.*

No. 8 is a brown sandstone filled with *Chemung shells* and *Crinoidal fragments.* It comes in layers, one to two feet thick, and these break out in very regular prismatic blocks, since the joints are very even and close together.

Nos. 9, 10, 11, are also richly fossiliferous in *Spirifera, Rhynchonella, Leiorhynchus, Productella,* and many others, as well as multitudes of small *Crinoidal stems.*

☞ This is the lowest *Chemung rock* in the two counties.

This section taken with the preceding one $2\frac{1}{4}$ miles south give a continuous exposure 250′ below the top of the *Chemung.*

As we pass northeastward from Cascade Bridge, along the N. Y., L. E. & W. R.R, the rocks still continue to rise quite rapidly, and at the *Summit cut,* 5 miles away, the *New Milford lower sandstone* has an elevation of 1250′ A. T. having risen 275′ from the vicinity of Susquehanna Depot, $1\frac{1}{2}$ miles below which it has an elevation of 1250′ A. T.

At the *Summit cut* which is in the State of New York, and about three miles north of this township, we see an exposure of 150′ of red and brown shales, interstratified with thin layers of more sandy material. Just above this the massive *New Milford Lower sandstone* juts out in a vertical cliff.

Anticlinal.—This ridge seems to represent a low axis which may be a continuation northward of the Moosic Mt. range. As we pass eastward from it the strata dip rapidly down; for, when we come to Deposit, 7 miles away, the base of the *New Milford Lower sandstone* has fallen to 1050′ above tide or a dip of (1525′—1050′) 475′ in this distance, or 70′ per mile.

In the high knob just east of Starrucca creek at Lanesboro', a sandstone 150′ above the base of the *New Milford group* has been extensively quarried and used in building the great viaduct across the Starrucca valley on the N. Y., L. E. & W. R.R. It is a greenish gray rock, tolerably hard, and seems quite durable.

In passing up Starrucca creek from Stevens' Point, the outcrop of the *New Milford Sandstone group* is almost constantly seen, the massive members jutting out of the hills in lines of vertical cliffs. I was informed that near Webster's mill a *seam of coal* 1″ to 2″ thick is seen in one of these sandstones.

Along the Susquehanna in this township the Drift is very thickly piled in immense heaps, but no crystalline bowlders were seen in any of the material.

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9. Thompson, in Susquehanna county.

This is a small area lying directly south from Harmony, and like it, adjoins the Wayne county line.

It is drained principally by Starrucca creek, the left branch of which takes its rise in the southern, and central portions of the township.

The rocks belong to the middle portion of the *Catskill series.*

The surface is very rough, and huge cliffs of sandstone are seen in almost every hill, while large bowlders cover the ground almost everywhere.

Just west from Starrucca Depot, the following section was seen in descending the steep hill to the Jefferson Branch R. R.: (Fig. 22.)

Starucca depot section.

1. Massive white sandstone,	Honesdale Group.	20′
2. Red rock, sandy,		40′
3. Massive sandstone,		20′
4. Red shale,		50′
5. Sandstones, shales, and concealed to level of Starucca depot (1424′ A. T.,)		180′

No. 1 is the *Honesdale upper sandstone*, and comes here 1714′ A. T.; is very massive, and immense grayish-white blocks of the same are seen scattered over the surface.

No. 2 is the peculiar *red sandstone* which we always find interpolated between the two members of the *Honesdale sandstone group*. It has a very fine grain and lamination, but yet is quite sandy and often found in rounded bowlders in the Drift deposits.

On the opposite side of the creek from Starrucca Depot, No. 1 is seen in a great massive cliff extending around the hills.

At the high trestle of the Jefferson Branch R.R., over a stream in the northeastern corner of this township, a massive grayish-green current-bedded sandstone 20′ thick is seen just below R.R. level.

On the country road between Thompson Station and Ararat, many very massive cliffs of sandstone are seen jutting from the hills, while at some localities the surface of the ground is almost entirely concealed from view by the great numbers of huge *bowlders* that have broken away from the neighboring cliffs.

Barometric elevations in Thompson.

	A. T.
Cross roads at western line of Thompson near E. M. Bryant's,	1530′
Forks of road near F. O. Potter's, ...	1610′
" " H. Jenkin's, ...	1680′
Cross roads in borough of Thompson, ...	1645′
Forks of road near G. A. Crosier's, ...	1700′
Cross roads near C. H. Hubbard's, ...	1895′
Level of Wrighter's pond, ...	1950′

10. Jackson, in Susquehanna county.

This lies next west from Thompson, having Oakland at the north and Gibson for its south boundary.

The northern half of this area drains northward into the Susquehanna river, while the southern half, though draining in an opposite direction, finally reaches the Susquehanna by way of Tunkhannock creek.

The rocks of the township belong entirely to the *Catskill series*, the highest ones belong to the *Honesdale sandstone group*, which caps some of the highest hills in long lines of grayish-white cliffs.

In the northwestern corner of this township, the *New Milford upper sandstone* is seen near the house of Mr. C. Stevens. It forms a line of cliffs around the hill and is 40′ thick, its base having an elevation of 1600′ A. T. This is most probably the same rock as the "Hinkerma Ledge" north of Great Bend Depot, for its top comes here about 400′ above the base of the *Catskill sandstone series*, since, two miles and a half north, the base of the *New Milford Lower sandstone* is seen at 1250′ above tide, and there is probably very little dip in the intervening distance.

Just south of the *New Milford Upper sandstone ledge* at Mr. Stevens', we come to the base of another massive sandstone at 1785′ A. T. a grayish-white rock and much current-bedded.

On the hill west from the Baptist Church near B. Larabee's, the outcrop of a white sandstone is seen capping the summit at an elevation of 1840′ A. T.; it most probably belongs to the *Honesdale sandstone group*; this is about the elevation at which it should be found. Two hundred feet lower, at this locality, we see the base of another massive greenish gray sandstone.

About one mile and a half north from this, near Yale School House, a great sandstone mass is seen extending from 1625′ to 1725′ A. T. in several beds interstratified with shales.

Near the western line of the township, at Mr. L. Perry's, a grayish-green sandstone is seen cropping out at 1600′ A. T. and extending up to 1650′ at top. It would seem to represent the *New Milford Upper sandstone* but may possibly be one somewhat higher in the series.

Barometric elevations in Jackson.

	A. T.
Forks of road near G. Stevens',	1510′
" " T. Galloway's,	1590′
Forks near western line of Thompson, just west from O. H. Perry's,	1525′
Cross roads near H. Barnard's,	1565′
Forks of road east from L. Perry's,	1595′
Cross roads near W. W. Holmes',	1650′
Forks of road near D. A. Lamb's,	1260′
" " one mile west,	1500′
Cross roads near A. M. Pease's,	1720′

Forks of road near C. H. Estabrook's,	1705′
" " G. Gelatt's,	1725′
" " M. Gates',	1750′
Level of Butler lake,	1665′
Forks of road near E. B. Larabee's,	1625′
" " W. D. Birdsall's,	1640′
" " T. Perry's,	1615′
" " F. Yale's,	1580′
" " A. Bolch's	1485′
Cross roads near C. Witter's,	1525′

11. New Milford, in Susquehanna county.

This is one of the largest townships in the county, and lies directly west from Jackson, while Great Bend forms its northern boundary.

The northern half is drained by Salt Lick creek northward into the Susquehanna river, while the southern half sends its drainage southward by way of Martin's creek and the head branches of the Tunkhannock, all of which finally reaches the Susquehanna.

Drift-filled divide.—A very singular feature, in the topography, is seen in the manner Martin's creek heads up against one of the branches of Salt Lick. The two streams are separated by a very low Drift-filled "notch" in the divide, while the hills both east and west rise 500′ higher. This great cut through the divide may have been made in either of two ways, that is, by Glacial ice advancing southward, or flowing water coming northward. I incline to the former hypothesis, and believe that the great notch is the result of ice erosion during the Glacial epoch. But if this be not true, then in preglacial times, a stream of water, much larger than the present, Salt Lick took its rise much further south, and flowing northward along what is now Martin's creek, gradually cut its way down through the rocks ; but subsequently a large dam of morainic débris was piled so high across its channel at the present summit of the "notch" by Glacial agencies, that the water in its southern channel found a lower outlet southward into the Tunkhannock system, probably through a glacial cut, so that subsequently we had two streams going in opposite directions.

The D. L. & W. R.R. passes across the low gap thus made in the divide, and the bed of its track at the summit is 1150′ A. T. while the real summit at the top of the cut is 25′ higher or 1175′; making a fall of (1175′—860′) 315′ from that point to the mouth of Salt Lick creek at Great Bend; while Martin's creek on the other side falls (1175′—700′) 475′ from the summit to its mouth at Tunkhannock creek, near Nicholson in Wyoming county, just south from Susquehanna.

Immense *piles of Drift* material are seen all along both valleys. One mile below New Milford, a very large heap of bowlders, gravel, and sand has furnished the most of the ballasting along the D. L. & W. R.R. This gravel bank has been worked back toward the hill for several rods and shows a face of exposure 90′ high. In this we see rounded bowlders of every description *except metamorphic* fragments, none of which I could discover; commingled with the bowlders are much sand and gravel, often having the appearance of rude stratification. This *moraine* once extended clear across the valley, but has been cut through by the stream, since on the opposite, or west side of the creek, a huge mound of morainic débris is still seen extending westward to the adjacent hill at the same elevation as the ballast deposit.

The rocks of this area belong to the *Catskill system*, with the exception of a short and narrow trench, cut into the very top of the *Chemung* by Salt Lick creek, where it leaves the township at its northern line. But although the top of the *Chemung* is there above drainage, none of its rocks are exposed, since everything along the valley is concealed by a deep covering of Drift.

From the village of New Milford in this township I have named a group of sandstones which come in the lower portion of the *Catskill*, and are in fact the beginning of the *Catskill sandstone series*, as follows: (Fig. 20.)

New Milford section.

1. Sandstone, massive, (*New Milford upper*),	40′
2. Shales, red, sandstone and concealed,	110′

3. Sandstone,	20′
4. Shales, sandstone and concealed,	100′
5. Sandstone,	25′
6. Shales, red and green,	80′
7. Sandstone, massive, *New Milford Lower*, (base 1160′ A. T.),	15′

The *New Milford upper* and *lower sandstone* seem to be quite persistent, and occur at many points in the district. No. 5 is also quite persistent, and frequently crops out in cliffs over this and adjoining townships. The sandstones of the group are all current-bedded and more or less divided into layers 1″ to 3″ thick.

At New Milford the *lower sandstone* occurs in a cliff along the hill opposite the R.R. station; above it No. 5 makes a very bold cliff, from here south to the summit; immense blocks broken away from it lie scattered over the hill below.

Anticlinal.—A low axis seems to cross the measures in this township, near the R.R. cut across the summit-divide between Salt Lick and Martin's creeks; for the rocks rise southward from New Milford to that summit and then immediately begin to dip down in the same direction.

About two miles north from New Milford the following is seen in descending to Summerville along the road from the crest of the hill on the east side of Salt Lick creek: (Fig. 24.)

Salt Lick creek section.

1. Sandstone, massive, (bowlder?),	25′
2. —— Concealed,	80′
3. Sandstone, *New Milford upper*,	65′
4. —— Concealed,	225′
5. Sandstone, massive,	25′
6. —— Concealed, with occasional oucrops of *red shale* to level of Salt Lick creek at Summerville,	255′

At the horizon of No. 1 a great mass of grayish white sandstone was seen projecting from the hill; but as it occurs at only one locality, it may possibly be a bowlder which has come down from a stratum somewhat higher; since many masses looking very much like it are scattered over the surface both above and below that horizon.

The *New Milford upper sandstone* is rather flaggy or shaly toward the top, but very massive in the lower 25′; it forms the summit of the divide; the road leading across it passes along a narrow defile cut down 50′ perpendicularly on either side.

No. 5 is the same stratum as No. 5 of the preceding section at New Milford.

In No. 6, occasional outcrops of *red shale* are seen, and the base of this interval extends down nearly to the top of the *Chemung*.

In ascending the hill from New Milford toward Montrose a very massive sandstone is seen at 1500′ A. T.; it forms a line of cliffs around the hills, and is also seen on the opposite or east side of the valley. Above this sandstone, which is the *New Milford upper*, we see *red shale* from 1600′ to 1650′; at 1655′ A. T. we come to a massive sandstone; with another one above it 75′ higher up the hill.

At the roadside near Mr. T. B. Wilson's a massive sandstone at 1550′ A. T. has been quarried; of a greenish gray color, in layers one half to one foot thick.

In descending the hill from Mr. Wilson's to Beaver creek at School House No. 5 a large amount of red shale is seen at 1300′ to 1350′ A. T.

In passing south from New Milford the base of the second cliff rock at No. 5 of the section there, is frequently seen at 1240′ A. T. Two miles south the following section was taken in descending a sharp point: (Fig. 25.)

Two miles south of New Milford.

1. Sandstone, massive,	20′
2. Red shale,	70′
3. Sandstone, massive,	20′
4. —— Concealed,	100′
5. Sandstone, (base 1285′ A. T.),	20′
6. —— Concealed to level of road,	75′

No. 5 is the same stratum which occurs in the hills at New Milford 1250′ A. T., and its elevation here (1285′) shows a rise southward of 35′ in the mile between the two points.

An anticlinal must therefore exist a short distance south from this locality, since one mile further south the rocks are seen dipping in the opposite direction. The stratum in question is easily traced from New Milford, being visible

Fig. 22.
Thompson.

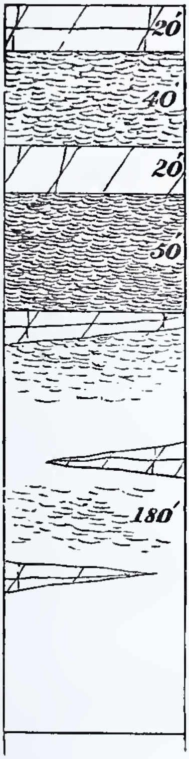


Fig. 23.
New Milford.

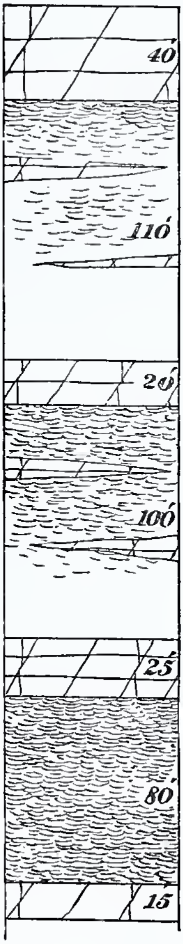
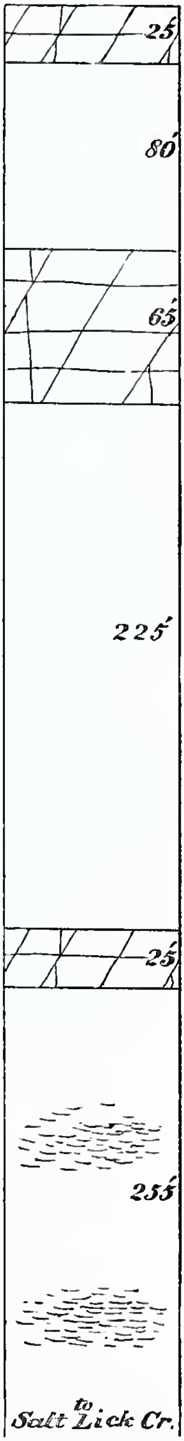


Fig 24.
Salt Lick Cr.



in an almost continuous line of cliffs on either side of the stream.

One mile east from the last locality we come to a massive ledge of sandstone 25′ thick, 255′ above the base of No. 5 of the preceding section, and this makes it very probably the *New Milford Upper sandstone.* 180′ above this we come to the base of another very massive rock, grayish-white in color; much red shale is seen below it, while above it for 50′ is seen a reddish shaly sandstone.

One mile east from the last locality and on the land of Mr. L. S. Everett a very massive sandstone is seen at 1730′ A. T.

In going directly south from School House No. 2 to Mr. H. Drinkers the *New Milford Upper sandstone* is seen at 1500′; and above this *red shale* occurs along the road up to 1535′ A. T. In the hill above this a very massive grayish white rock begins at 1645′ and covers the summit with very massive blocks, as well as a neighboring hill with a very bold cliff outcrop.

The same massive rock is seen near H. Seymore's estate, in the southern portion of the township; base at 1575′ A. T.

Just at the Harford township line another massive sandstone comes in at 1645′ on whose top at 1665′ are seen many *glacial striae*, going S. 30° W. magnetic; on the other side of the hill immediately below this sand rock 60′ of *red shale* occurs along the roadside, and this brings us down to another sandstone, the one seen near Mr. Seymore's.

In school district No. 7 near the Grinnell School House the following section is seen: (Fig. 26.)

Grinnell school-house section.

1.	Sandstone, massive, grayish-white,	25′
2.	—— Concealed,	50′
3.	Sandstone,	25′
4.	—— Concealed,	45′
5.	Sandstone,	30′
6.	—— Concealed to base of *New Milford Lower sandstone* at S. line of the township on the D. L. & W. R.R.,	500′

The upper portion of this section must come near the horizon of the *Honesdale sandstone group*, since it is 675′ above the base of the *Catskill sandstone series.*

Near the southern line of the township on the D. L. & W. R.R. and ¾ mile above Montrose Depot, a massive gray, current-bedded sandstone 25′ thick is seen 30′ above the R.R. track; it occurs in a cliff for a considerable distance and contains many plant remains; olive and reddish shales come in below it.

About 2 miles above Montrose Depot a bed of *calcareous conglomerate* with *fish fragments*, rises above R.R. level, and a short distance above another *fish conglomerate* comes in as exhibited in the following: (Fig. 27.)

Two miles above Montrose depot.

1. Sandstone, flaggy,	10′
2. Sandstone, massive,	10′
3. *Fish conglomerate*,	5′
4. Shale, blue, to track level,	2′

Only 50 feet further up the track the *fish conglomerate* entirely disappears, and we obtain the following: (Fig. 28.)

1. Sandstone, (same as No. 2 of preceding),	10′
2. Shale, olive and blueish,	4′
3. Sandstone, dark-gray to track level,	4

The *fish conglomerate* can be seen gradually disappearing between these two sections; it is a *calcareous* rock filled with pieces of greenish-blue slate, and small *fish fragments*, much worn, and entirely undeterminable with reference to specific or generic characters.

About 40 rods further north along the R.R. track, a very massive current-bedded sandstone is seen 45′ above the level of the same, and this is the *New Milford Lower sandstone*. The following is seen there: (Fig. 29.)

1. Sandstone, massive, (*New Milford Lower*,)	20′
2. Shales and sandstone,	25′
3. Sandstone,	10′
4. Shale, brick-red, to R.R. level,	10′

About 100 yards above this, the following is seen in a R. R. cut: (Fig. 30.)

1. Sandstone, massive, gray,	20′
2. Shale, olive,	4′
3. *Shale, red,* to track level,	16′

No. 3 is the same as No. 4 of the preceding section, only we see 6′ more of it here, since the strata are rising quite rapidly to the north. A short distance above this, another local *fish conglomerate* is seen just below the lowest member of the preceding section.

Keeping still further north along the R.R. we see 50′ to 60′ more of *red shales* rise successively above the level of the track and finally about half way between New Milford and Montrose Station a sandstone, of fine grain, and greenish color comes up and has been quarried extensively at the side of the D. L. & W. R.R. It is rather a massive ledge and 20′ thick down to R.R. level. *The New Milford Lower sandstone* juts out of the hill 140′ above the track level, and 120′ above the base of the *red shale*, thus making about 90′ of that stratum at this locality, since the *red shale* comes in immediately above the quarry sandstone.

In the next cut, 100 yards above this, 40′ of greenish sandstone is seen below the red shale, and one fourth mile above that the following is seen along the R.R. track:

1. Sandstone, greenish gray,	25′
2. Shale, olive, friable,	6′
3. Sandstone, green, flaggy, to R.R. track,	10′

The Wilmot anticlinal axis here crosses the D. L. & W. R.R. (3 miles south from New Milford) and as we go north the rocks dip down instead of rising, so that the sandstones of the preceding section soon pass under track level and the *New Milford red shale* above them comes down. One mile above the stone quarry and 2½ from New Milford *50′ of red shale* is seen in a cut along the R.R. When we come to the summit cut, 1 mile south from New Milford the *New Milford Lower sandstone* shows in a cliff there 30′, above the track level.

It has also been quarried for flagging to a considerable extent on the land of Mr. Bartle, just south of the summit cut.

Barometric elevations in New Milford.

	A. T.
Forks near T. Y. Keely's,	1180′
" L. Hancock's,	1345′
" G. S. Frink's,	1560′
" E. Beebe's,	1565′
" G. G. Ely's,	1565′
" T. R. Wilson's,	1555′

Fig. 25.
New Milford.

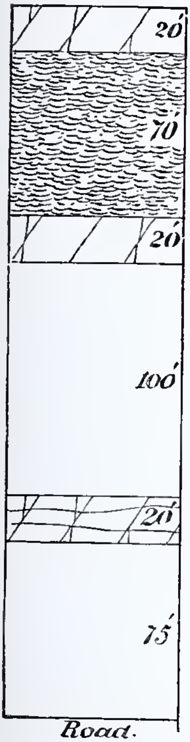


Fig. 26.
Grinnel School H.

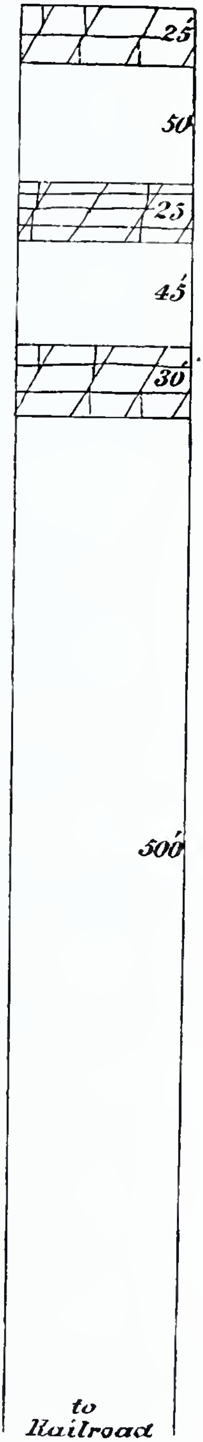


Fig. 27.
2 m. above
Montrose Depot.

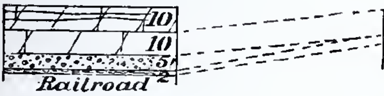


Fig. 28.

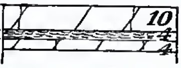


Fig. 29.

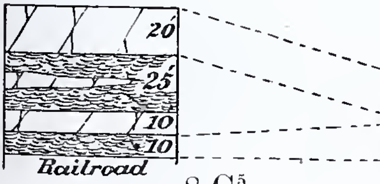
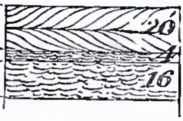


Fig. 30.



G5.

Level of Beaver creek at School House No. 5,	1285′
Forks near J. E. Sherwood's,	1525′
" W. W. Harrison's,	1385′
" School House No. 1,	1010′
Level of Salt Lick at Summerville,	995′
Forks near H. H. Van Cott's,	1240′
" School House No. 9,	1365′
" L. S. Everett's,	1650′
Forks next south near cemetery,	1545′
Forks east of C. D. Williams,	1520′
Forks near C. G. Page's,	1400′
Level of pond just west,	1390′
Forks of road near School House No. 15,	1420′
" next east,	1455
Cross roads near J. W. H. Bradford's,	1590′
" E. J. Tyler's,	1485′
" School House No. 13,	1485′
Forks near R. C. Richardson's,	1525′
" School House No. 2,	1210′
" R. Gillespie's,	1205′
" F. T. Wellman's,	1300′
Forks next southwest,	1390′
Cross roads near H. Grinnell's,	1625′

12. *Bridgewater, in Susquehanna county.*

This is a very irregular shaped area, lying directly west from New Milford.

Near its center, on a very elevated plateau, the highest land in the western half of this county, is situated the county seat, Montrose.

The drainage goes off toward almost every point of the compass, but it all finally reaches the Susquehanna river.

The rocks of this township belong entirely to the *Catskill series*, though in the northern portion the valleys of the streams are cut down nearly to the *Chemung* or probably within 100′ of its top.

In the vicinity of Montrose, are a series of massive sandstones which crop out in bold bluffs around the hills, and from their elevation above the base of the Catskill, would seem to come at the horizon of the *Honesdale group*.

The following succession is seen in the vicinity of Montrose: (Fig. 31.)

Montrose section.

1.	Sandstone, massive, (base at 1820′ A. T.,)	40′
2.	—— Concealed,	20′
3.	Sandstone, massive gray,	25′
4.	—— Concealed,	30′
5.	Sandstone, gray,	20′
6.	Shales and gray sandstones,	40′
7.	*Red shale, Montrose,*	visible, 125

The top member of the series is the most massive layer in this sandstone group and may possibly be identical with the *Honesdale upper sandstone*, since it is much whiter than any of the others; and then, it comes at about 700′ above the base of the *Catskill sandstone series;* while the *Honesdale upper sandstone* comes at about 800′ above the same horizon at the eastern line of this county. All the other sandstones in this series are greenish gray, very much current-bedded and usually finely laminated.

The *Montrose red shale* was named from this locality; it is seen in many of the streets of the town on which excavations of any kind have been made, and is especially noticeable along Wyalusing street; also along the Milford and Owega turnpike. The shale is almost blood red and contains very few sandy layers.

If the top stratum of this series represents the *Honesdale upper sandstone* then is the *Montrose red shale* horizon identical with the *red shale* in the Honesdale hill section; and so far as we can determine the fact they are identical, since both come at about the same horizon (1000′) above the top of the *Chemung.*

In the northeastern portion of this township, the surface rises to 1900′ above tide, and takes in the *Montrose sandstone group* near its summit.

Near Mr. Corwin's a ledge of massive sandstone is seen at 1655′ A. T. and above it at 1725′ another one makes its appearance.

Just west from this the hills take in the higher series and we get the following succession: (Fig. 32.)

McCorwin's ledge section.

1.	Sandstone, grayish-white,	30′
2.	—— Concealed,	25′

3. Sandstone, gray,	20′
4. —— Concealed,	40′
5. Sandstone, gray, massive,	25′
6. —— Concealed,	20′
7. Sandstone, gray,	20′

No. 1 of this section is identical with No. 1 in the Montrose section, and the sandstones of the series below are the same as those found below it at Montrose, although the *red shale* is not reached here in the section, because the exposure does not extend down far enough.

In ascending the hill road from School House No. 9 we see a *flag quarry* along the roadside on the land of Mr. Mulford at an elevation of 1535′ A. T.; the rock is of a grayish-green color, and comes in layers 2″ to 4″ thick.

As we continue on up the hill, the outcrop of the *Montrose red shale* is seen in a broad band of red across the road; and at 1665′ above tide, we come up to the base of another massive sandstone.

At the western line of Bridgewater, near O. E. Green's, several massive beds of sandstone are seen in long lines of cliffs commencing at 1575′ A. T. and extending up to 1725′. They are most probably a portion of the *Montrose series*, since there is a slight dip to the westward from the neighborhood of Montrose.

One mile west from E. E. Chamberlin's, a massive member of the *Montrose sandstone series* is seen in the summit of the hill at 1670′ A. T. Two miles east, in the hill near B. Millards, the same rock is seen in a bold cliff, its base coming there 1670′ A. T. Two more massive layers are seen above it extending to the summit of the hill at 1735′ A. T.

Near the county Poor Asylum some massive sandstones are seen, and one crops out at 1450′ A. T. This would come just below the base of the *Montrose red shale horizon*.

One mile northeast from Montrose, is a beautiful sheet of water called Jones' Lake, about 6 acres in extent, and surrounded by banks of Glacial débris, thus proving that its basin is of Glacial origin either by direct erosion or by the daming up of a preëxisting valley.

Barometic elevations in Bridgewater.

	A. T.
Forks at west line of Montrose borough near S. Casey's . .	1565′
Forks near E. A. Fessenden's, ...	1445′
“ school-house No. 2, ...	1310′
Cross roads near G. Frink's, ...	1255′
Forks near D. Green's, ...	1650′
“ Mrs. C. Hinds, ...	1300
Level of Jones's lake, ...	1580′
Cross roads at A. Frink's, ...	1660′
“ school-house No. 8, ...	1660′
Forks northeast from J. McCollum's, ...	1675′
“ next east, ...	1635′
Cross roads at L. Gardner's, ...	1620′
“ J. L. Griffin's, ...	1540′
Level of Hart lake, ...	1540′
Forks near Mrs. H. Ludington's, ...	1625′
“ next east, ...	1645′
Cross roads near A. Stephen's, ...	1735′
Forks at school-house No. 9, ...	1425′
Level of pond near by, ...	1415′
Forks near W. Lewis's, ...	1460′
“ south from O. M. Crane's, ...	1730′
“ at Poor Asylum, ...	1435′
Cross roads near J. Watrous's, ...	1260′
Forks near school-house No. 4, ...	1220′
“ south of W. T. Austin's, ...	1220′

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13. Jessup in Susquehanna county.

This is a small area lying directly west from the southern half of Bridgewater.

It is drained entirely by the waters of the Wyalusing westward into the Susquehanna river, in Bradford county. This stream cuts a deep valley through the central portion of the township, falling about 200′ in its course through the same.

The rocks of this area belong entirely to the *Catskill*, though the continued cutting down of the Wyalusing, brings its valley within 200′ of the *Chemung* series at the western line of the township.

At Fairdale, on the south bank of Wyalusing, a very bold cliff of massive sandstone is seen skirting the hill at 1375′ A. T.; it belongs in the *New Milford group*, and probably comes about 100′ below the top of the same.

About three quarters of a mile east from Fairdale P. O. a bed of *red shale* is seen of which 20′ to 30′ are exposed at the roadside.

Along the bed of the Wyalusing at T. F. Cooper's a stratum of massive sandstone is seen at 1090′ A. T. and this is most probably the *New Milford Lower sandstone.*

At School House No. 4, one mile below Cooper's, a cliff sandstone is seen in the hill at 1300′ A. T. and 150′ higher in the hill another makes its appearance ; this last stratum probably represents the *New Milford Upper sandstone* since its base has an elevation of 1450′ above tide.

The highest summits in this township extend up to about the horizon of the *Montrose red shale*, but as it is soft and easily disintegrated, no exposure of it was seen, since the roads do not pass over any ground high enough to catch it, and along nothing else do we get any shale exposures in this township.

Barometric elevations in Jessup.

	A. T.
Forks of road near J. T. Whitacres,	1220′
Cross roads at Fairdale P. O.,	1145′
Level of Wyalusing near by,	1105′
Forks near D. Hoff's	1120′
" S. McKeeby's,	1125′
" A. Bolles,	1100′
" School-house No. 4,	1135′

14. *Forest Lake, in Suquehanna county.*

This lies west from the northern half of Bridgewater, and directly north from Jessup.

The drainage passes into the Wyalusing, except a small area at the extreme northern line, which goes northward by way of Choconut and Snake creeks.

The rocks of the township belong exclusively to the *Catskill*, though where the middle branch of Wyalusing passes out of the township, the top of the *Chemung* can not be much over 100′ below its bed.

Near the south-western corner of this township, the *New Milford Lower sandstone* is seen in a cliff along the hills, on the land of Mr. G. Dewel ; the stratum is 20′ thick and quite massive ; base 1140′ A. T.

At Birchardsville, a massive sandstone, seen making a cliff in the hills at 1375′ A. T., belongs in the *New Milford group*, and probably comes near its middle.

At the forks of the road near W. Reinvault's, in the south-east corner of the township, the *Montrose sandstone group* is seen commencing at 1665′ A. T., and extending with many bold cliff outcrops up to 1765′.

Barometric elevations in Forest Lake.

	A. T.
Forks near G. Dewel's,	1100′
“ N. Miller's,	1100′
Cross roads in Birchardsvlile,	1130′
Forks near J. B. Fessenden's,	1170′
“ W. C. Tilden's,	1200′
“ School House No. 9,	1240′
“ H. Baldwin's,	1340′
“ next east,	1500′
“ “	1715′
“ Mr. Meeker's at Forest Lake P. O.,	1560′
“ C. Loomis's,	1475′
“ J. Green's,	1445′
“ W. Rheinvault's,	1735′
“ H. L. Ball's,	1740′
Level of Forest Lake,	1560′

15. *Middletown, in Susquehanna county.*

This lies directly west from Forest Lake, and extends to the Bradford county line for its western boundary.

All of the drainage passes south into the Wyalusing thus finally reaching the Susquehanna river.

The rocks of this area belong mostly to the *Catskill*, though in some of the valleys the top of the *Chemung* is just reached, or ought to be, since at some localities they are trenched 200′ below the base of the *New Milford Lower sandstone*.

A large quantity of Drift is scattered over the surface, and in it are seen some small bowlders of *granite* and other *crystalline rocks*.

Oil boring.—Near the center of the township, at Mr. J.

Cahill's, a hole was bored, commencing in the valley of North Wyalusing at 1040′ A. T.; it was drilled to a depth of 680′ but no oil was obtained; plenty of gas was found, and also salt water at 300′.

Salt well—Here salt was manufactured forty years ago, water being obtained from a boring about 300′ in depth; the well was cased with *copper tubes*, and I was informed by Mr. Cahill, that the salt finally became so *poisonous* that dogs and cats could not eat substances seasoned with it without fatal results.

In the hill on the right bank of the Wyalusing the *New Milford Lower sandstone* is seen just opposite the bore hole, at an elevation of 1250′ A. T. or 200′ above the valley; hence the boring begins at the very top of the *Chemung series*. The *New Milford Lower sandstone* makes a bold cliff along the hill, and dips quite rapidly to the south, probably 100′ to the mile.

Near the southern edge of this township, and one mile east from its western line, a great deal of *red shale* is seen along the road at 1100′—1150′ above tide, and this is the same *red shale* which is seen along the D. L. & W. R.R. in New Milford, below the New Milford Lower sandstone.

Barometric elevations in Middletown.

	A. T.
Forks of road at J. Cahill's,	1080′
Cross roads at Middletown Center,	1060′
Forks of road near Mrs. Hickey's,	1010′
" E. Stedwell's,	1010′
" J. Biglan's,	985′
" G. L. Wells',	1070′
" L. W. Hardy's,	1060′

16. Rush, in Susquehanna county.

This lies immediately south from Middletown and like it adjoins the Bradford county line.

Wyalusing creek flows directly west through its center, and receives all the water from this area, except a very small surface at the southwestern corner which drains off southward through Tuscarora creek.

The rocks of the township belong to the *Catskill series*, with the exception of a narrow trench in the top of the *Chemung* along the lower portion of Wyalusing, and also along the North Branch of the same; but while the top of the *Chemung* is thus above drainage along the valley of the Wyalusing and its branches, there is no locality in the township where any of the rocks of the series are exposed, because *Drift* covers everything along the channels of the streams, and often far up the sides of the hills.

The massive lower member of the *New Milford group* is often seen skirting the tops of the hills on either bank of the Wyalusing in bold cliff outcrops 200′ to 250′ above the level of the stream.

Just above Grangerville this *New Milford Lower sandstone* is seen on the north bank of the stream at an elevation of 1100′ A. T. and quite massive.

At the cross roads, about one mile below Grangerville, the same *New Milford Lower sandstone* is seen and there we get the following: (Fig. 33.)

Grangerville section.

1. Sandstone, massive, gray,	25′
2. —— Concealed,	75
3. *New Milford lower sandstone*, (base 1135′ A. T.),	20′
4. —— Concealed,	80′
5. Red shale, seen,	25′
6. —— Concealed to level of the Wyalusing,	80′

No. 1 is the massive cliff-rock which so often comes 80′ to 100′ above the base of the *New Milford Lower sandstone;* it is here quite massive, current-bedded, and crops out in a bold cliff along the hills.

About two miles directly north from this last locality, near Tupper's school-house, the *New Milford Lower sandstone* is seen at an elevation of 1150′ A. T. at base; it juts of the hill out in a very massive ledge, and is also current-bedded.

Near the western line of this township, at the mouth of the North Branch of the Wyalusing, the *New Milford Lower sandstone* comes in the hills 270′ above the level of the stream or 1140′ A. T. Therefore if the *Drift* did not conceal everything along the valley we should see about 75′ of the uppermost *Chemung rocks.*

The *Drift* is largely composed of rounded and angular bowlders of local sedimentary rocks, but occasionally we find a small one of *granite* or other *crystalline rocks* all rounded and polished by attrition.

Near A. F. Shaddock's, in the northwestern portion of the township, a great cliff of sandstone is seen extending along the hill on the west bank of North Wyalusing, at an elevation of 225′ above the same and 1145′ A. T. The rock is a greenish-gray current-bedded sandstone and has a thickness of 25′; it is the *New Milford Lower sandstone*, and is frequently seen between this and the mouth of the North Branch.

Barometric elevations in Rush.

	A. T.
Forks of road near R. Reynold's,	1050′
Level of Wyalusing just opposite,	1010′
Forks in Grangerville,	1025′
Forks near H. H. Gray's,	1080′
Cross roads near W. L. Vaughn's,	965′
Level of Wyalusing just opposite,	950′
Forks near Mrs. M. Hillis's,	1015′
Level of Middle Wyalusing near by,	990′
Forks near L. C. Tupper's,	1015′
" M. Bradshaw's,	1075′
" J. C. Shaddock's,	935′
" H. Carter's,	920′
" N. Hillis',	885′
Level of Wyalusing near by,	870′
Forks near J. T. Hillis's,	900′
" D. Hillis's,	985′
" J. M. Franee's,	1470′
" East Rush P. O.,	1245′
" B. A. Jones',	1360′
" A. C. Steadman's,	1245′

17. *Dimock, in Susquehanna county.*

This lies east from Auburn, and the drainage is southward by way of White and Meshoppen creeks into the Susquehanna river.

The rocks of the township all belong to the *Catskill se-*

ries, but in some of the deep valleys the interval to the top of the *Chemung* is not great, possibly not more than 300′ in some localities.

The outcrop of the massive *Catskill sandstones* are often seen ; but only one or two of the hills are high enough to catch the horizon of the *Montrose sandstones.*

Near Dimock a somewhat massive sandstone is seen at 1550′ A. T. and this may possibly represent one of the lower members of the *Montrose sandstone series.*

As this area is a common heading ground for streams, none of them cut down very far into the rocks, and hence everything is concealed by *Drift* and débris, so that very few exposures of any kind of rock occur.

Barometric elevations in Dimock.

	A. T.
Forks near J. Kellogg's,	1245′
" Fargo's and Young's,	1355′
Level of Elk Lakes,	1350′
Cross roads near George Steven's,	1430′
Forks next east,	1530′
Forks near Mrs. J. Sawyer's,	1440′
Forks next east,	1360′
Level of run near H. F. Newton's,	1340′
Cross roads near C. M. Hickley's,	1450′
Forks of road near E. P. Tiffany's,	1270′
Level of Meshoppen Branch, just east,	1170′
Cross roads south from A. Hazleton's,	1260′
Forks of road in Parkvale,	1060
Cross roads near P. Tiffany's,	1130′
" B. Rose's,	1100′
Forks near I. Reynold's,	1130′
" A. Landsey's,	1140′
Forks just north of J. Rosecrantz's,	1170′

18. Brooklyn, in Susquehanna county.

This lies directly east from Dimock and has Martin's creek for its eastern boundary.

The township is drained southward into Tunkhannock by Hop Bottom and Martin's creeks.

The rocks of this area belong entirely to the *Catskill series*, since the *New Milford Lower sandstone* passes below drainage on Martin's creek at the northern line.

Along the eastern bank of this latter stream, passes the *Delaware, Lackawanna and Western R.R.* in the cuts of which are seen many outcrops of the massive sandstones, *red shales* and *calcareous coglomerates* of the Catskill.

The following section taken just opposite Oakley Station near the southern line of the township illustrates well the character of the *Catskill series* in this township: (Fig. 34.)

Oakley Station section.

1.	—— Concealed from top of hill,	30′
2.	Sandstone, massive, (top 1167′ A. T.,)	20′
3.	Flaggy sandstone,	5′
4.	*Calcareous breccia,*	1′
5.	Gray flaggy sandstone,	10′
6.	*Red shale,*	35′
7.	Red sandstone and red shale,	30′
8.	Gray shale,	5′
9.	Sandstone, massive, currrent-bedded,	25′
10.	*Calcareous breccia,*	2′
11.	Sandstone,	3′
12.	*Shale, red,*	12′
13,	Sandstone, greenish gray,	20′
14.	*Shale, red,*	10′
15.	Sandstone, massive,	40′
16.	*Calcareous breccia,*	6′
17.	—— Concealed to level of Martin's creek,	40′

No. 2 is a grayish-green current-bedded sandstone like all the other sandstones in this section.

No. 6 is a *bright red shale* and no sandy layers are seen in it.

No. 7 has several layers of red sandstone interstratified with dark red shale.

Nos. 4 and 10 are examples of the *calcareous breccias* or *fish conglomerates* which are so common in the *Catskill rocks*, being found near the bases of many sandstones as sporadic masses which may be absent in the next section, only a few rods away. They contain in this case many pebbles of shale, and sandstone, as well as fragments of *fish bones*.

No. 13 is quarried to some extent at this locality, on the land of Mr. M. Underwood; the rock on its outcrop, has a massive appearance, but when quarried into the hill it splits up into thin layers 3″ to 6″ thick, which make beautiful

Fig. 31.
Montrose.

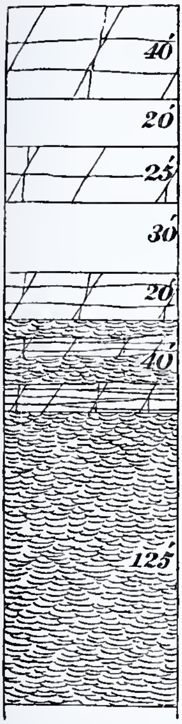


Fig. 32.
Mc Corwin's Ledge.

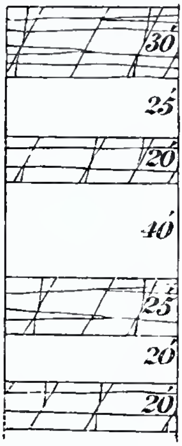


Fig. 33.
Grangerville.

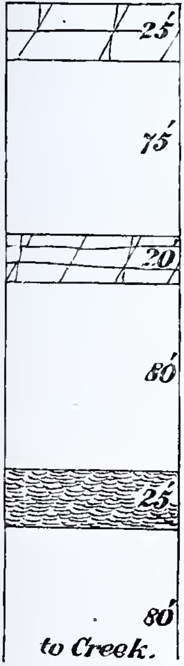
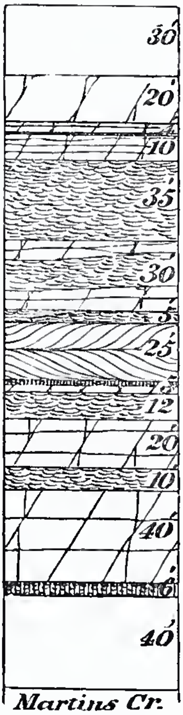


Fig. 34.
Oakley Station



G5.

flagging; many fragments of *fossil plants* are seen on the surface of the flagstones; too much macerated for determination however.

No. 16 is a very hard *calcareous fish conglomerate*, and is seen for several rods in the cuts of the D., L. & W. R.R. It is almost as hard as granite; and contains great quantities of bluish-green shale in pieces the size of a silver dollar, and upwards; it also contains many fragments of grayish or bluish-white material, which very probably represent *fish bones.*

At Montrose Depot a succession of massive sandstones is seen outcropping along the steep hillside on the right bank of Martin's creek. Far up in the hills, 300′ above the Depot, a very massive one occurs, and this is the *New Milford Upper sandstone*, or the rock that usually comes 350′ above the base of the *Catskill sandstone series;* large grayish-white blocks of it lie scattered over the hill from top to bottom.

The valley of Martin's creek, though quite narrow, is filled with *Drift* and it is very possible that a tongue of the northern ice sheet stretched from the Susquehanna valley across from Big Bend by way of the Salt Lick creek cutting down the divide at the head of Martin's creek in its path, and extending southward along its valley, since the *Drift material is different* from that on the summits of the hills, and the same as that left in such huge heaps along the Salt Lick valley, on the northern side of the divide.

Just south of Tewksberry School House, one mile west from Martin's creek, we see *Glacial striæ*, at the roadside trending S. 30° W. magnetic; they are on one of the grayish-green sandstones of the *Catskill* and at 1515′ A. T.

About one half mile south from Tewksberry School House, an elevated knob is capped with a cliff of grayish-white current-bedded sandstone at an elevation of 1610′. This is most probably one of the *Montrose sandstones*, since one mile west from this the base of the *Catskill sandstone series* occurs at 950′ A. T. (1610′—950′)=660′ below the sandstone on Tewksberry hill.

One mile south from South Pond, at the cross roads near

Mr. Fairchild's, a very massive sandstone is seen at 1440′; it most probably represents a stratum in the interval between the *Montrose group* and the *New Milford Upper sandstone.*

Barometric elevations in Brooklyn.

	A. T.
Forks one half mile south of Montrose Depot,	1120′
Forks near H. Tewksberry's,	1335′
Cross roads at Tewksberry School House,	1460′
" near W. R. Page's,	1490′
Forks near C. A. Williams',	1500′
" J. Baker's,	1315′
Forks in Brooklyn village,	1180′
Forks next east,	1125′
Forks near L. F. Porter's,	1140′
Cross roads near H. G. Fairchild's,	1440′
Forks near F. L. Lindsey's,	1470′

19. *Harford, in Susquehanna county.*

This lies directly east from Brooklyn, from which it is separated by Martin's creek.

The drainage is all southward into Tunkhannock creek by several tributary streams.

The northern line of this area extends nearly to the crest of the divide which separates the waters flowing northward into the Susquehanna river from those going southward.

The outcropping rocks belong entirely to the *Catskill system* and extend from the base of the *New Milford Lower sandstone* up to the *Montrose series.*

Along the D., L. & W. R.R. which ascends the valley of Martin's creek, many good exposures of the lower and middle portions of the *New Milford sandstone series* are seen.

About three fourths of a mile above Montrose Depot, and just at the northern line of the township, a massive sandstone is seen in cliffs along the R.R. It is very much current-bedded, contains many fragments of *fossil plants*, and is most probably the *New Milford Lower sandstone.* Below it are seen olive and red shales 15′ thick to level of R.R. track.

As we pass down Martin's creek from this point, the rocks dip rapidly down, and when we come to Montrose Depot, the *New Milford Lower sandstone* disappears below drainage at an elevation of 1000′ above tide. The *dip* here is about 75′ to the mile, but it does not continue so rapid for any considerable distance.

Three fourths of a mile below Montrose Depot, the following is seen in a cut along the D., L. & W. R. R. :

Below Montrose.

1. Sandstone, massive,	15′
2. —— Concealed,	20′
3. Sandstone, flaggy,	10′
4. Massive,	10′
5. Shales and flaggy sandstone to level of track, (1045 A. T.,)	35′

Nos. 1 and 3 are grayish-green current-bedded rocks, and crop out in massive cliffs.

Just below this point the lower portion of No. 5 becomes massive and also forms a cliff along the track.

About one fourth mile further down the R.R. we see *4′ of red shale* passing under the roadbed immediately below a massive sandstone, and 20 rods further still, *20′ of red shale* pass below the track with a massive grayish-green sandstone directly above.

About two miles above Oakley Station, a steep ravine leads into the left bank of Martin's creek. Descending it the following was obtained near the R.R. water tanks :

Two miles above Oakley Station.

1. Sandstone, massive, gray,	20′
2. —— Concealed,	30′
3. *Shale, red,*	10′
4. Sandstone,	20′
5. Sandstone flaggy to R.R. level (980′ A. T.),	10′
6. Sandstone, massive, visible,	10′

No. 3 is a very dark red stratum coming between two layers of gray current-bedded sandstone.

Just above Oakley Station the following is seen on the left bank of Martin's creek in descending steep to the R.R. :

Oakley Station section.

1. Sandstone, massive,	30′
2. —— Concealed,	150′
Forks next east,	1440′

3. *Calcareous breccia*,	6′
4. Shale, bluish green,	1′
5. Shale *red* to level of Oakley Station, (942′ A. T.,)	2′

No. 1 is much current-bedded, has very thin layers, and makes a long line of cliffs around the hills; it belongs in the *New Milford series*, and may possibly represent the *New Milford Upper sandstone;* which would give a *dip* of only 50′ per mile between Oakley and Montrose Depot.

No. 3 is one of the *impure limestones* of the *Catskill*; it is seen along the railroad for several rods and is almost as hard as granite; contains probably 25 per cent. of carbonate of lime, and great quantities of pieces of the underlying bluish-green shale, together with what appears to be fragments of *fish bones*, so broken and triturated however by the rapid current which deposited the stratum, as to be almost indistinguishable from the other material. The lime in the rock has the appearance of having been partly derived from the trituration, or breaking up of a pre-existing limestone.

A short distance down the track from where this section was taken, we see a massive sandstone immediately above the *impure limestone*, and this latter rock dips below R.R. level just before we come to Oakley Station.

About two miles north from Harford village, on the summit of the hill near Mrs. Leech's, a series of very massive sandstones is seen beginning at 1445′ A. T. and extending up the hill in several beds (each separated by 20′ to 30′ of shales) for 200 feet. On one of these beds at 1455′ A. T. are seen many *glacial striæ* going S. 25° W. magnetic; the upper surface of the rock is planed off quite smooth and the parallel groves vary in depth from $\frac{1}{4}$ to $\frac{1}{2}$ inch, while the breadth varies from $\frac{1}{2}$ to 4 inches.

Near School House No. 3, $1\frac{1}{2}$ miles east from Montrose Depot, a quite massive sandstone is seen capping the hills at 1600′ above tide, and it may possibly represent one of the *Montrose group*.

Barometric elevations in Harford.

	A. T.
Cross roads near T. Carpenter's,	1360′
Forks near A. M. Stearn's,	1390′

Forks near School House No. 3,	1540′
“ “ 4,	1325′
“ Mrs. Leech's,	1435′
Cross roads near Partner creek in Harford village,	1265′
Forks near D. Roe's,	1300′
“ Miss S. K. Titus',	1500′
Cross roads near A. Tingley's,	1375′
Forks near W. W. Wilmarth's,	1065′
“ School House No. 8,	1050′
“ P. Harding's,	1035′
Forks next south,	965′

20. Gibson, in Susquehanna county.

This lies directly east from Harford having Jackson on its northern boundary and Clifford on its southern.

The drainage is all southern by way of Tunkhannock creek and its many branches.

From the valley of the Tunkhannock creek eastward the surface rises quite rapidly, attaining at the eastern line of the township an elevation of 1800′ to 1900′ A. T. while toward the southern border it becomes quite mountainous.

The rocks of the township belong entirely to the *Catskill system*, though in some places the Tunkhannock trenches nearly to the top of the *Chemung*. It is quite possible that at the north-eastern corner of the township this stream cuts a little below the base of the *Catskill;* but the hill slopes are covered with *Drift* and no rock exposures are to be seen.

At the forks of road near L. W. Scott's, northwest from Gibson, we see a massive cliff rock jutting out of the hill at 1300′ A. T. It belongs to the top of the *New Milford group.*

On the opposite or eastern side of Gibson village the same rock is seen in a long range of cliffs from which many huge *bowlders* have broken away, and now line the hill slopes and valley below.

In descending along the Herrick Center road to Gibson we get the following succession :

Gibson section.

1. Sandstone, massive, grayish white,	30′
2. —— Concealed,	35′

3. Sandstone, gray,	20′
4. —— Concealed,	30′
5. Sandstone, greenish gray,	20′
6. —— Concealed,	200′
7. Sandstone, gray, massive, (base 1300′ A. T.,)	25′
8. —— Concealed to level of creek,	100′

No. 1 comes near the horizon of the *Montrose group* since if No. 7 be the *New Milford upper* (as seems probable) No. 1 would then lie about 700′ above the base of the *Catskill sandstone series.*

Much *calcareous conglomerate* or *fish-bone rock*, is seen along the outcrop of No. 1, but the stratum is much thinner than the *Cherry Ridge Limestone* ; and besides, comes at least 200′ below that horizon.

At the village of Smiley P. O. the sandstone seen near Gibson at 1300′ occurs in a line of cliffs on either side of the valley 140′ above the same and 1220′ A. T. ; it dips rapidly southward and no exposures occur below it.

In ascending the road from Smiley toward Herrick Center we come to the base of a massive sandstone at 1645′ A. T. and above this a *flag-stone quarry* extends to 1695′. Then some shale comes in. At 1725′ a massive gray sandstone with *calcareous layer* at base is seen in cliffs around the hills. Putting these rocks in a section and beginning on the summit of the ridge above, near the eastern line of the township, we would get the following succession : (Fig. 35.)

Smiley section.

1. *Cherry Ridge Conglomerate,*	25′
2. —— Concealed,	40′
3. *Cherry Ridge sand and limestone,*	20′
4. —— Concealed with occasional sandstones,	200′
5. Sandstone, massive, grayish white,	25′
6. Shales,	30′
7. Sandstone, massive and flaggy,	50′
8. —— Concealed,	300′
9. Sandstone, massive, gray,	25′
10. —— Concealed to level of Tunkhannock,	140′

Nos. 1 and 3 are seen on the summit of the ridge at the eastern edge of the township, where they form a double line of cliffs around the hills, blackened by the weathering of the great masses of *calcareous conglomerate* found at the base of each stratum. The calcareous divisions of these sandstones are each 6′ to 8′ thick and consist of *angular breccia* of *shale, limestone, pebbles of sandstone* and what appears to be *fish fragments*. These are the most characteristic rocks in the *Catskill series*, and have been traced clear through from this point to Cherry Ridge in Wayne county ; so that no doubt exists as to their identity or place in the rock series.

This section also serves to identify the *Honesdale sandstone series* of Wayne with the *Montrose series* of Susquehanna since No. 5 of this section is the representative of the *Honesdale Lower sandstone* which, from its elevation 1725′ A. T. must be also one of the *Honesdale series*. A layer of *calcareous conglomerate* is also seen at the base of No. 5, but it is only two to three feet thick, and quite irregular, frequently disappearing entirely within short distances.

About two miles above South Gibson, the base of a massive sandstone is seen at 1075′ A. T. along the roadside ; it is most probably the same as the one occurring 140′ above the valley at Smiley P. O. which would give the rocks a *dip* southward of nearly 100′ per mile between the two points.

Near the forks of the road at J. Guild's, one mile south from Gibson, a cliff sandstone is seen at 1500′ A. T. and above it, several other massive layers occur in the hills up to 1650′ A. T.

Barometric elevations in Gibson.

	A. T.
Forks near J. H. Claflin's, ...	1175′
Forks next east, ...	1165′
Cross roads at Gibson School House, ...	1250′
Level of Van Winkle's creek at Gibson, ...	1200′
Forks near A. Sweet's, ...	1365′
Forks next southeast, ...	1490′
Forks near E. P. Shepardson's, ...	1535′
Cross roads on Kennedy hill, ...	1635′
Forks next southeast, ...	1515′
Forks near Gelatt P. O., ...	1175′
Cross roads near Milliken & Smiley's, ...	1115′
Level of Tunkhannock at Smiley P. O., ...	1075′
Forks near S. R. Holmes' hotel, ...	1115′
" C. Fuller's, ...	1215′

Forks near S. Howell's,	1425′
“ W. Walker's,	1600′
“ H. Huckabone's,	1870′
Forks one mile south of Gibson,	1485′
Five Points Presbyterian Church,	1535′
Forks near J. Reynold's,	1475′
Cross roads near D. C. Roberts',	1350′
Forks near W. M. Taylor's,	1075′
“ W. H. Collum's,	1050′
“ J. Williams',	1060′
Cross roads in South Gibson,	1015′
Forks near H. Conrad's,	1000
“ W. Gardner's,	975′
“ W. Owen's,	1130

21. Ararat, in Susquehanna county.

This is a small area lying directly east from the northern half of Gibson and adjoins the Wayne county line.

It is a very elevated region, and thus becomes the common heading ground for several streams.

The extreme northern border drains northward into the Susquehanna by way of Starrucca creek ; the western portion drains southwestward into Tunkhannock, the eastern ern and southern portions by way of Lackawanna river.

The elevation of this township as a whole is very great, since the Jefferson Branch R.R. crosses the plateau at 2023′ above tide through a cut in morainic débris 30′ deep.

The evidence of *Glacial action* all over this area is abundant in the deep pile of angular, scratched and worn bowlders and such general débris as that seen at the summit. It is true that no scratches on rocks *in situ* were seen within the township ; but this was from lack of proper exposure, since everything is covered thickly with Drift, and no exposures of the upper surfaces were found along the roads.

Huge masses of the *Cherry Ridge black limestone* are seen scattered over all the township in such a manner as nothing except Glacial ice could have effected.

We have here positive evidence that the *Mer de Glace* atattained an elevation of 2100′ at least in crossing the great plateau.

At the northern line of the township the following section is seen in descending the hill across the R.R. from near Mr. J. Beaumont's: (Fig. 36.)

Beaumont's section.

1.	Sandstone, with *calcareous breccia* at base,		20′
2.	Shales and sandstone,		25′
3.	*Cherry Ridge*, Sandstone,	15	25′
	Limestone,	10′	
4.	*Red shale* and concealed,		100′
5.	—— Concealed,		70′
6.	Sandstone, massive, grayish white,		30′

Here the hill is covered with great blocks (many of which are 8′×10′×12′) of *black impure limestone* derived from the layers at the bases of Nos. 1 and 3; the *bowlders* frequently lay athwart the course of the Jefferson Branch R. R., and the trackmen report that their removal required as much labor as though they had been wholly of granite, so tough and hard are these rocks.

The *calcareous breccia* at the base of No. 1. is about 5′ thick while that in No. 3 is 10′.

At the horizon of No. 4 a great mass of *red shale* is seen along the road; although the interval is partly concealed it is quite probable that it is mostly *red shale;* the color is a rather bright red and the shale somewhat sandy in some of its layers.

No. 6 occurs at the horizon of the *Honesdale Lower sandstone* and is here a grayish-white, massive, tolerably coarse sandrock.

In descending from Ararat Summit westward to the waters of Tunkhannock we see the following succession: (Fig. 37.)

Ararat section.

1.	CHERRY RIDGE CONGLOMERATE, (here sandstone,)		25′
2.	—— Concealed,		30′
3.	*Cherry Ridge*, *Sandstone*,	20′	30′
	Limestone,	10′	
4.	—— Concealed,		175′
5.	Sandstone, grayish white, (*Honesdale Lower*,)		30′
6.	—— Concealed,		100′
7.	Sandstone, greenish gray,		20′
8.	—— Concealed,		220′
9.	Sandstone,		25′
10.	—— Concealed,		200′
11.	Sandstone, gray, massive, (base 1250′ A. T.,)		20′

Fig. 35.
Smiley.

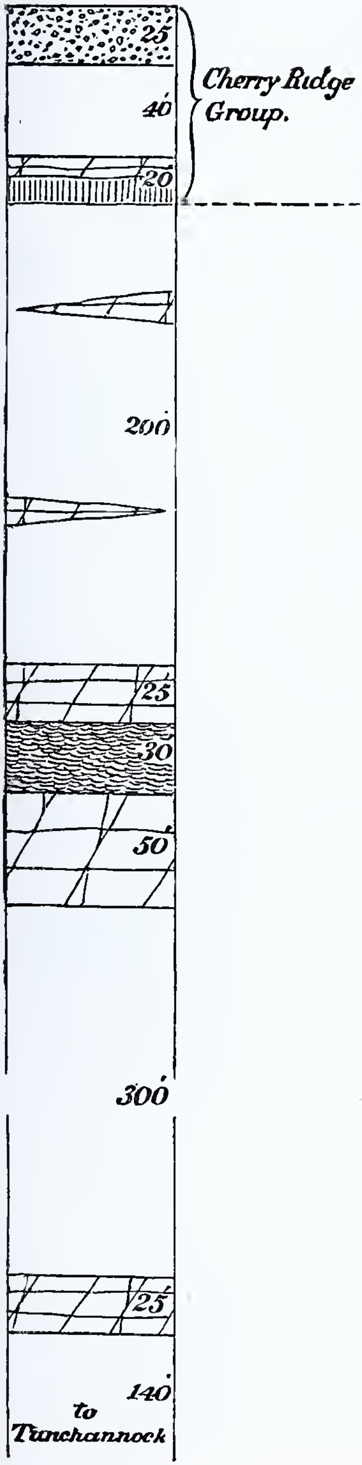


Fig. 36.
J. Beaumont

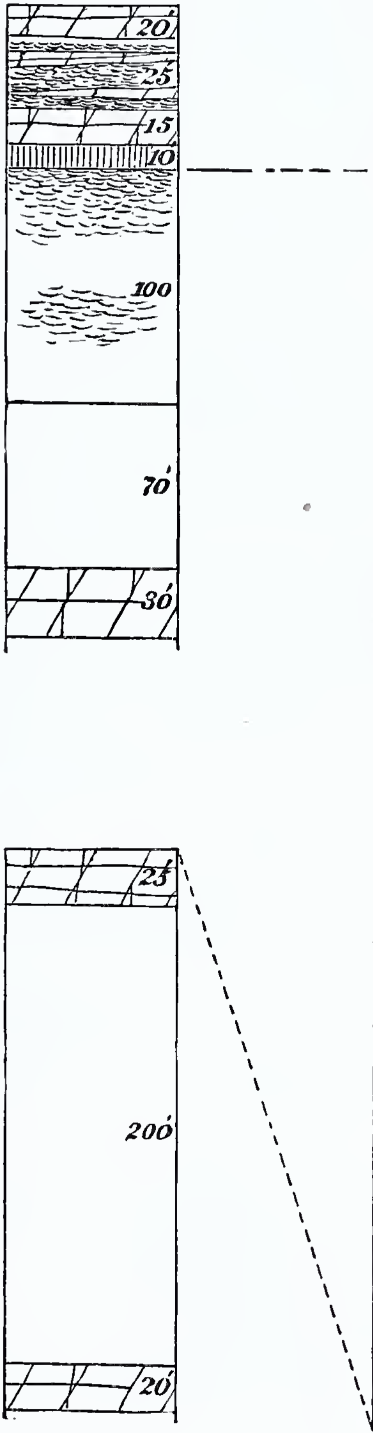
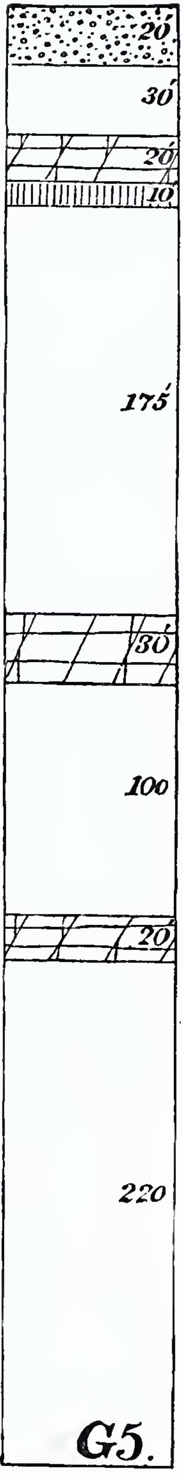


Fig. 37.
Ararat.



G5.

The vertical height of this section, serves to illustrate the rapidity with which the surface falls away to the westward, when it is stated that it was obtained in traveling a distance of only 2½ miles in a direct line; it also exhibits in a striking manner the enormous erosion to which this region has been subjected. The Tunkhannock valley here carries only a small amount of water.

Barometric elevations in Ararat.

	A. T.
Forks near J. Beaumont's,	2015′
Cross roads at Ararat Summit cut,	2070′
Summit just west,	2100′
Cross roads near H. Barnes',	2000′
Forks near N. J. West's,	1815′
" E. L. Avery's,	1450′

22. Herrick, in Susquehanna county.

This lies directly south from Ararat, and like it, has Wayne county for its eastern boundary.

The head branches of the Lackawanna river and the tributaries of East Tunkhannock (southward flowing streams) drain this township.

Much of the surface has an elevation of nearly 2000′ A. T. and in the south western corner of the same we find the culminating point of the State. In what is locally known as the Elk mountains there are twin peaks, the North and South knobs, which overtop by hundreds of feet everything else for miles around them.

North knob, as determined by barometer, has an elevation of 2700′ which is higher than any other known elevation in the State, except in its south-western districts.

South knob, one mile away, and just at the south line of the township rises to 2575′. These determinations were closely checked and re-checked from Herrick Center (1803′) on the Jefferson R.R., only four miles away, so that they are as likely to be a few feet *below* as *above* the true altitude; at any rate they can not vary more than 25 feet either way from the truth.

On the South knob, at an elevation of 2400′, is a wide level projecting ledge of rock formed by a cliff of the *Mount Pleasant conglomerate.* From this point one of the grandest pamoramas to be seen in the State bursts upon the eye, and the locality has long been known as Prospect Rock.

From this elevated summit the eye takes in at one sweep, the valley of East Tunkhannock 1200′ below, Crystal Lake, set like a jewel among the hills, the curling smoke from the hundreds of mines along the Lackawanna, as far south as Scranton, while beyond this still, in a long line of billowy crests, rise the blue outlines of the Moosic mountain range. A carriage road extends to within a short distance of the "view" and it is frequently visited by pleasure parties.

The rocks of the township belong entirely to the *Catskill series*, with the exception of the gray sandstones capping the North and South knobs of Elk mountain which should most probably be included in the *Sub-carboniferous.*

The following succession is seen in descending from the summit of North knob past Mr. Burdicks: (Fig. 38.)

North Knob section.

1.	Sandstone, gray, current-bedded,		20′
2.	—— Concealed,		175′
3.	Sandstone,		10′
4.	Red shales and concealed,		100′
5.	*Mt. Pleasant Conglomerate,* (base of X,)		20′
6.	*Red shales* (Mt. Pleasant,) top of IX,		150′
7.	—— Concealed,		150′
8.	*Cherry Ridge Conglomerate* (sandstone,)		20′
9.	—— Concealed,		30′
10.	*Cherry Ridge,* Sandstone,	10′	20′
	Limestone,	10′	
11.	—— Concealed with occasional outcrops of sandstone,		290′
12.	Sandstone, massive,		25′
13.	—— Concealed,		150′
14.	Sandstone,		20′
15.	—— Concealed with much sandstone to level of East Tunkhannock (1300′) at J. Barnes in Clifford,		215′

This long section is obtained in traversing an air line distance of only two miles. There is every probability that when the broad valley of East Tunkhannock was buried under the ice the elevated peaks of North and South Knobs rose above the *Mer de Glace* like islands. There are no marks of glacial action on their summits or indeed on their sides above an elevation of 2200′.

No. 1 is a rather coarse, very hard, and massive, current-bedded sandstone. It caps the summit of North Knob in a bold line of cliff outcrop and has protected it from erosion. This stratum underlies the *Carboniferous conglomerate No. XII* by about 900′, according to my identifications.

The *Mt. Pleasant conglomerate* is quite a prominent rock in this series; it forms a long line of cliffs around the sides of both knobs and is a conspicuous object from a great distance. The stratum is mostly a coarse sandstone, but near its base is a layer 4′ to 6′ thick, containing quartz pebbles of a reddish or rose color; there is also often a *calcareous* layer at the base of the rock.

Nos. 8 and 10 make conspicuous bluffs and cliffs around the hills; each has a layer of *calcareous conglomerate* or *brecciated impure limestone* at its base, but the lower one No. 10 is most massive, forming a huge black band of outcrop as far as the eye can reach. Some quartz pebbles occur in the calcareous layers here.

Nothing is seen of the massive white sandstones which usually come 200′ below the *Cherry Ridge Limestone;* but as everything is concealed by a deep covering of débris at that horizon, they may be present nevertheless.

No. 14 is a rather dark sandstone, and contains irregular masses of *calcareous breccia.*

This section ends just across the south line of Herrick, in Clifford, and the lowest portion is undoubtedly in the *New Milford sandstone group*, most probably near the top of it.

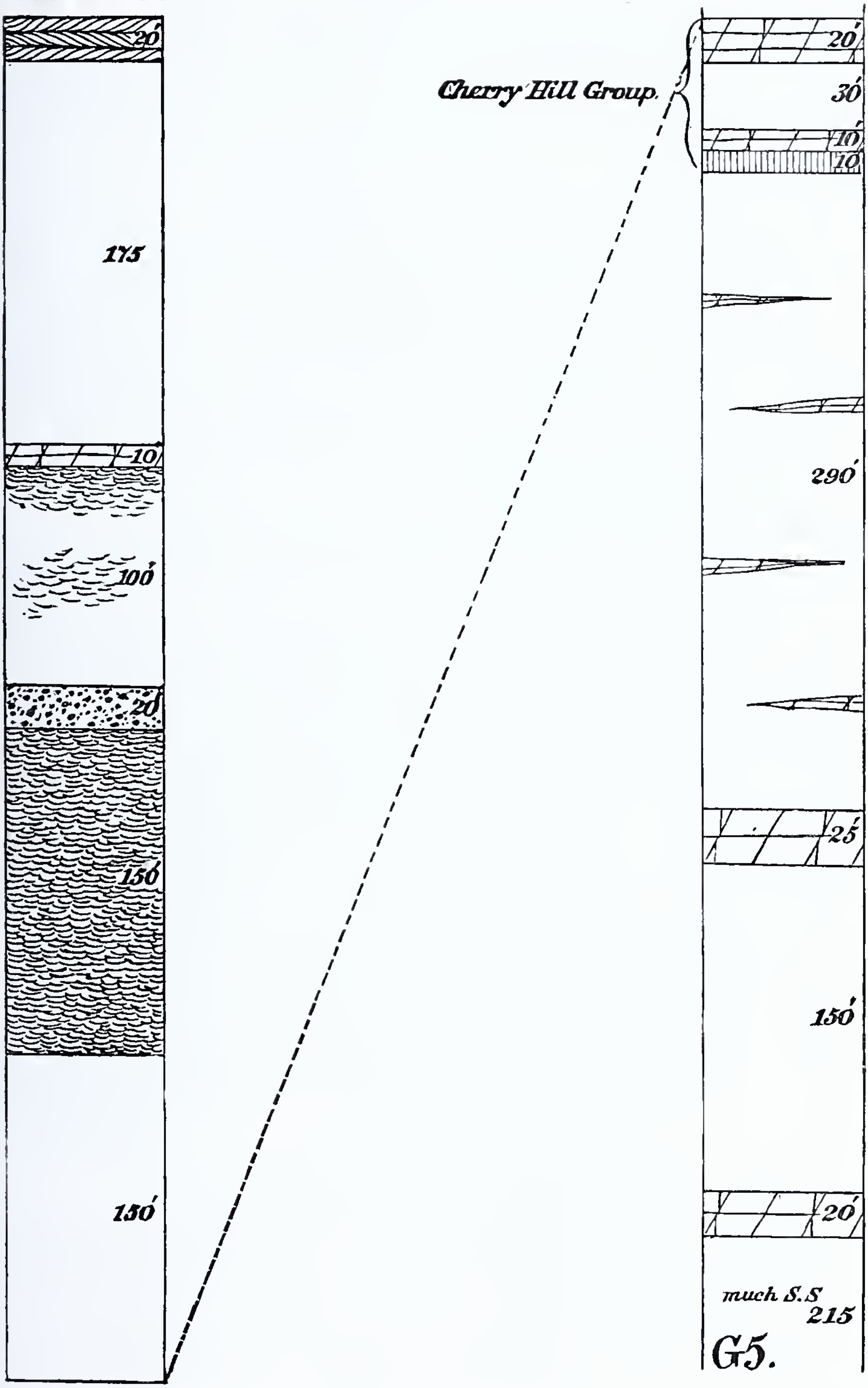
The *Cherry Ridge limestone* is seen all along the western range of this township at an elevation varying from 1950′ to 2000′ A. T., and it is usually accompanied by a duplicate mass of almost the same quality and appearance at the base of the *Cherry Ridge conglomerate* 50′ to 60′ above it.

The surface of the ground is often strewn thickly with huge black *bowlders* from these strata which have been torn off and transported by glacial action.

In many portions of this township at an elevation of 2000′ A. T. there are abundant evidences of *glaciation*, in the

Fig. 38 a.
North Knob

Fig. 38 b.



transported bowlders and great thickness of morainic material. These are especially numerous in the vicinity of Low Lake, a long body of water near the center of this area.

Barometric elevations in Herrick.

	A. T.
Forks west from J. B. Walker's,	1870′
“ T. E. Jones's,	1905′
Cross roads near H. Dart's,	1875′
Forks near L. Bunnell's,	1915′
“ E. Tiffany's,	1860′
Summit of South Knob,	2575′
“ North Knob,	2700′
Cross roads near W. E. Jones's,	2015′
Forks of road near J. Plue's,	1985′
Level of Low lake,	1905′
Level of creek near A. Chandler's,	1875′
Forks of road near C. S. Tingley's,	1920′

23. Clifford, in Susquehanna county.

This large area, directly south from Herrick, occupies the southeastern corner of Susquehanna.

It is drained by Lackawanna river and the East Tunkhannock, the latter carrying off much the larger portion of the rainfall.

The rocks of this township extend from near the base of the *Catskill sandstone series* up through the *Sub-carboniferous* into the *Anthracite Coal Measures*. Hence this is the only township within the county or district that contains any valuable beds of coal. The reason for it seems to be this: The elevated anticlinal range of the Moosic highland forks near the northeastern line of the township, the eastern branch keeping on southward as the main Moosic range, while the western branch extends southwestward through the southern corner of Clifford as the Lackawannock mountains; the two arms of the anticlinal having thus separated a canoe-shaped snyclinal comes in along what had previously been the crest of the anticlinal fold and dipping rapidly down to the south, catches the basal members of the *Coal measure rocks* near the southeastern corner of Clifford.

There is only one workable bed caught in the township, and only about 150 acres of that. It has been mined quite extensively for some time by the Hillside Coal and Iron Co. at Forest City, about one half mile north from the southern line of the county, and one fourth of a mile from the eastern line.

Mr. Jno. S. Hines of Scranton, Lackawanna county, is the general manager of the company and from him the following facts were learned:

The outcrop of the coal is struck at 850 feet from the Forest City Station on the Jefferson Branch R.R. and about (guess) 60′ above the same. The coal is a very pure anthracite and from 0′ to 6′ in thickness, the average workable portion being 4½′. 70 acres of the coal have already been taken out or developed, and there is probably not more than 70 acres remaining. The company when working full time puts out 2500 tons per month. There is another coal 4′ to 5′ thick below the one wrought, but it is too slaty and impure to warrant mining at the present state of the anthracite trade. The company have bored some holes with diamond drills in hopes of developing other valuable coals below the one they are now working, but so far they have not been successful, and from the nature of the case can never be, since the coal they are operating is the *first* one above the lower division of the *Great conglomerate* that is ever workable in the Lackawanna coal basin.

The records of the diamond drill were kindly placed at my disposal by Mr. Hines.

The following bore-hole began at the bottom of an air shaft, on the coal now mined by the company, and reads thus, Fig. 39:

Bore hole A.

1.	Shaft to bottom of coal, (Forest City.)	68′	0″
2.	Shale,	6′	0″
3.	Sandstone,	27′	0″
4.	*Coal,*	0′	6″
5.	Sandstone,	32′	8″
6.	Slate,	2′	6′
7.	Coal,	0′	2″
8.	Slate,	22′	6″

9.		*Coal,*	1′ 6″	4′ 2″
		Dirt,	0′ 6″	
		Coal,	2′ 2″	
10.	Slate,			13′ 6″
11.	Sandstone,			14′ 0″
12.	Slate,			5′ 0″
13.	*Coal,*			0′ 6″
14.	Slate,			0′ 5″
15.	*Coal,*			0′ 6″
16.	*Slate and coal* mixed,			0′ 7″
17.	Slate,			1′ 0″
18.	Sandstone,			11′ 5″
19.	"Pea Conglomerate,"			1′ 0″
20.	Sandstone,			42′ 10″
21.	Slate,			12′ 0″
22.	Sandstone,			12′ 0″
23.	Coal,	Coal and slate mixed,	1′ 8″	8′ 4″
		Slate,	2′ 2″	
		Coal,	4′ 6″	
24.	Slate,			2′ 0″
25.	Sandstone,			4′ 0″
26.	Pea Conglomerate,			4′ 0″
27.	Sandstone,			16′ 0″
28.	"Pea Conglomerate,"			4′ 0″
29.	Slate,			2′ 4″
30.	Pea Conglomerate,			1′ 8″
	Total,			327′ 1″

The following was obtained in a boring a short distance west from the first: (Fig. 40.)

Bore hole B.

1.	Surface débris,	25′ 0″
2.	Sandstone,	29′ 10″
3.	*Coal,*	1′ 0″
4.	Slate,	2′ 7″
5.	*Coal,* (Forest City,)	8′ 0″
6.	"Rock," (sandstone,)	44′ 0″
7.	*Coal,*	1′ 0″
8.	Dark sandstone and slate,	17′ 0″
9.	*Coal* and slate mixed,	4′ 10″
	Total,	133′ 3″

On lot No. 5 near the D. & H. R.R. track another boring gave the following result: (Fig. 41.)

Bore hole C.

1.	Sandstone,	13′ 2″
2.	Slate,	19′ 0″

3. *Coal,* (Forest City,)	3′	6″
4. Slate,	2′	2″
5. *Coal,*	0′	6″
6. Slate,	2′	9″
7. "Hard rock," (sandstone,)	42′	3″
8. Slate,	1′	9″
9. Sandstone,	8′	8″
10. Slate,	7′	4″
11. "Hard rock," (sandstone,)	24′	10″
12. *Slate and coal* mixed,	2′	10″
13. Slate,	10′	0″
14. Hard rock,	13′	10″
15. *Coal,*	1′	6″
16. Slate,	0′	2″
17. *Coal,*	0′	6′
18. Slate,	5′	4″
19. Rock,	23′	7″
20. Black dirt,	3′	1″
21. Slate,	1′	4″
22. "Dirt,'	0′	8″
23. Slate,	2′	7′
24. Rock,	17′	5″
25. Sandstone,	10′	8″
26. *Coal,*	0′	5″
27. Slate,	0′	1″
28. "Pea Conglomerate,"	24′	10″
29. Slate,	4′	9″
30. "Pea Conglomerate,"	22′	9″
31. Slate,	0′	10″
32. Rock,	0′	1″
33. Slate,	0′	5″
34. "Pea Conglomerate,"	1′	2″
35. Slate,	0′	9″
36. Conglomerate,	3′	0″
Total,	279′	6″

The following was obtained in another boring not far from the last: (Fig. 42.)

Bore hole D.

1. Surface débris,	47′	0″
2. Slate,	3′	3″
3. *Coal,* (Forest City,)	6′	10″
4. Sandstone,	18′	2″
5. Slate,	3′	2″
6. *Coal,*	1′	6″
7. Slate,	7′	5″
8. Sandstone,	3′	11″
Total,	91′	7″

For comparison with these sections, see Fig. 1.

The coal wrought at Forest City seems to me, from the structure there, to be the equivalent of No. 6 of that section which is the lowest workable bed in the Carbondale, or Lackawanna coal basin.

No attempt was made at Forest City to work out the detailed structure, since the country is a wilderness, exposures are rare and it would have taken much more time than was at my disposal to have accomplished the task even if it can be done at all. Then too, the structure of this anthracite basin will be worked out in detail by other hands during the progress of the survey, and this most northern area will then receive its due share of attention.

I provisionally regard the previous sections as representing the *conglomerate measures* at the western line of Pennsylvania, the massive current bedded rock 75′ thick at the top of Fig. 1, being the representative of the *Homewood SS.*, while the *coal group* coming below it and including the Forest City bed would correspond to the *Mercer coal group* of western Pennsylvania, the *Alton group* of McKean and the *Bloss coals* of Tioga, and Bradford. This conclusion will seem reasonably warranted to any one who will carefully examine the structure of these coal fields as given in Reports G, G^2, G^3, Q^2, Q^3, and R.

The massive current bedded SS. or "Monkey Ledge" of Tioga and Bradford is a perfect parallel to No. 1 of the section (Fig. 1, page 44) which is found all through the Carbondale basin, and any one who has studied the two rocks in the field could with difficulty resist the conclusion that they are identical.

At the northern end of the Forest City coal field the dip is very rapid. Only one locality was found where it could be measured and this is in a cut on the Jefferson Branch R.R. near the southern end of Still Water pond. There it is 27° S., 30° E. The Lackawanna river at this point breaks through the northern branch of the Moosic mountain, and enters the synclinal trough of the Lackawanna or Third anthracite coal basin.

As we go north-westward from the Forest City region the rocks rise with great rapidity for about two miles from the

Diamond drill borings at Forest City.

Fig. 39

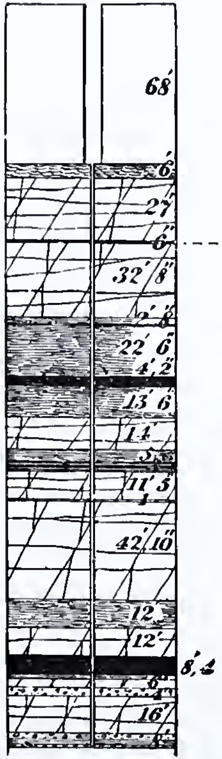


Fig. 40.

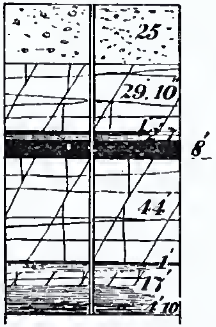


Fig. 41

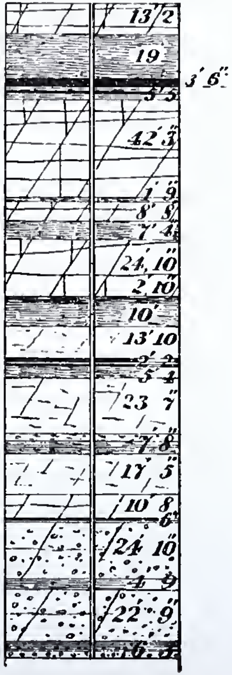
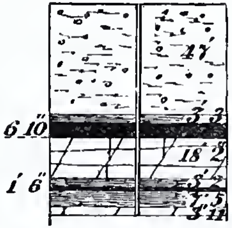


Fig. 42.



G 5.

center of the coal basin, and there the dip begins to flatten very fast, so that when we come to the Elk mountains at the northern line of the township and only five miles away, the strata have become almost horizontal.

The South knob of the foregoing range, is just at the northern edge of Clifford, and descending its summit the following section was made: (Fig. 43.)

South Knob section.

1.	—— Concealed from summit with occasional outcrops of red shale (2575′ A. T.,)		100′
2.	Sandstone, gray,		15′
3.	—— Concealed,		15′
4.	Sandstone, grayish white,		20′
5.	*Red shale,*		45′
6.	*Mt. Pleasant Conglomerate,* (base of X,)		20′
7.	*Red shale,* (*Mt. Pleasant,*) (top of IX,)		100′
8.	—— Concealed,		275′
9.	*Cherry Ridge,* Sandstone,	20′	30′
	Limestone,	10′	
10.	—— Concealed with SS. outcrops,		500′
11.	Sandstone, massive,		20′
12.	—— Concealed,		200′
13.	Sandstone, greenish gray,		25′
			1365′

Nos. 2 and 4 make cliffs around the knob; some pebbles occur in the latter; both exhibit much false bedding.

The *Mt. Pleasant conglomerate* runs out in a broad bare projecting cliff at the southern point of the mountain and forms a great bold ledge along its entire south-western face. It is from its upper surface that the remarkably fine view of the country to the southward is obtained, and from which it has received the name of "Prospect Rock."

Near its base we find a layer 2′ to 3′ thick filled with quartz pebbles, many of which are one inch in diameter. The most of them are reddish or rose colored and very irregular in outline.

Not all of the *Mt. Pleasant red shale* was exposed, but enough was seen at several horizons in it to show that the whole interval is of the same material; it is of a dark-red color and looks very much like the same stratum at Mt. Pleasant in Wayne county.

The *Cherry Ridge horizon* makes a conspicuous outcrop as usual, the *impure limestone* at its base weathering black and standing out in bold relief along the base of the cliffs formed by it and the overlying sandstone.

Nos. 11 and 13 are very hard and massive, grayish-green sandstones, and are seen about 1½ miles west from South Knob along the waters of a branch of Tunkhannock creek.

In the northwestern corner of Clifford, near E. Evans's, a bed of *red shale* 30′ thick is seen at 1150′, and above it 250 feet rise massive cliff-rocks like huge stepping stones, each being 20′ to 25′ thick, and separated from one another by small shale intervals.

At the cross roads, near the school-house in the Burdick district, a massive sandstone is seen extending from 1600′ to 1650′, and in the hill, 200 feet above, there occurs a stratum of very dark aspect much resembling the *Cherry Ridge limestone*, which no doubt it represents.

Near G. W. Hull's, 1½ miles east from Dundaff, a thick stratum of *Calcareous conglomerate* occurs at 1770′ and below it *red shales* are seen for several feet. This most probably represents the *Cherry Ridge limestone* since it has about the right elevation for that stratum.

At the very southern line of the township is Crystal Lake (elevation 1750′ A. T.) a beautiful sheet of water lying partly in Lackawanna county ; it is well stocked with fish and is a celebrated summer resort for the Carbondale and Scranton people. The proprietor of the Crystal Lake Hotel informed me that he sounded a depth of 120′ of water in the basin. It is surrounded with banks of Drift and fed by springs from the bottom as no stream flows into it ; the outlet is southward through a "notch" in the Lackawannock Mountains into the Lackawanna river.

The entire region around, is 1000′ to 1200′ lower than the top of the South Knob, and vast heaps of morainic débris are seen on every hand.

Two great Glacial currents seem to have come together around the southern point of South Knob one moving down from the northeast along the valley of East Tunkhannock and the other down the main branch of the same, just west of the Elk Mt. Range. After uniting, their course was more to the S. W. and rudely parallel to the Lackawannock Mountains.

Barometric elevations in Clifford.

	A. T.
Cross roads in Dundaff,	1620′
Forks near W. Meredith's,	1720′
Crystal lake,	1750′
Forks near Crystal Lake hotel,	1760
" C. H. Whitman's,	1800′
Lane near G. W. Hull's,	1710′
Cross roads near C. Burdick's,	1810′
Forks near G. H. Salsbury's,	1830′
" M. S. Gardner's,	1480′
Crossing of creek just north,	1380′
Forks near R. Barrit's,	1420′
" W. Burn's,	1335′
" J. Burn's,	1335′
" W. Reader's,	1435′
" P. Burdick's,	1300′
" E. Coleman's,	1290′
Forks at McAllas's Mills,	1285′
Cross roads just south,	1275′
Forks near J. Wells's,	1455
Lane near S. Arnold's,	1455′
Cross roads near T. Jones's,	1655′
Forks next west,	1535′
Cross roads near I. Morgan's,	1300′
Forks near J. Reynold's,	1295′
Cross roads near S. Owen's,	1435′
Forks northeast from E. Williams's,	1580′
Cross roads near R. Ellis's,	1415′
Forks near E. Jenkins's,	1385′
Forks ½ mile west,	1165′
Cross roads near Mrs. J. Weatherbee's,	1200′
Forks near A. Green's,	1145′
" P. Bennett's,	1095′
" R. L. Hunter's,	1085′
Level of East Tunkhannock near last,	1075′
Forks at Lonsdale,	1085′
Level of Tunkhannock at crossing next west,	1045′
Forks near W. Halstead's,	1055′

24. Lenox, in Susquehanna county.

This lies directly west from Clifford and has Lackawanna county for its southern boundary.

The main branch of the Tunkhannock creek enters the township at its northeast corner, and flowing S. W. through its center, drains the greater portion of the same.

The East Branch enters it from Clifford, and flowing nearly west along the southern border of the township joins the main stream just before the latter passes out of the county.

The rocks of this area belong exclusively to the *Catskill system*, since the horizon of the *Carboniferous* sweeps far above its highest hills, and the *Chemung* is buried several hundred feet below drainage level.

Nothing of any special interest is to be seen in this township. The same monotonous succession of *cliff sandstones*, massive and current-bedded, are to be seen in every portion of the same. They belong to the top of the *New Milford* and the *Montrose sandstone group.* The only change that they show from their outcrop further north and west is the increase of sandy and coarse material, and hence very possibly a marked *increase in thickness* between the northern and southern lines of the county.

This *increasing coarseness* is finely shown in the northeastern portion of the township at the junction of the Harford Branch with the main stream where an almost solid wall of rock 200′ high is seen on the south bank of Tunkhannock, there being probably not more than fifty feet of shale in the whole 200 feet.

The valleys are all filled with morainic débris, while the upper surface of the rocks on the uplands are scratched and scored with *glacial striæ*.

Lakes and lakelets are scattered over the township, among which are *Loomis*, *Round*, *Robinson*, *Tea*, and others.

Barometric elevations in Lenox.

	A. T.
Forks in Lenoxville,	1040′
Forks near J. S. Robinson's,	1080′
" H. Robinson's,	1045′
" Wm. Barber's,	985′
Level of creek just below mill,	960′
Forks near T. Halstead's,	1010′
Level of East Tunkhannock near H. Buck's,	900′
Forks near Charles Smith's,	900′
Forks next west,	900′

Level of Tunkhannock at mouth of East Branch,	815′
Forks near I. D. Hardy's,	835′
Forks north of Glenwood,	860′
Forks near O. D. Roberts's,	875′
" A. Benjamin's,	1300′
Cross roads near Baptist Church,	1330′
" H. Marcey's,	1385′
Forks near M. Conrad's,	915′
" C. Felton's,	965′

25 Lathrop, in Susquehanna county.

This lies directly west from Lenox and has Wyoming county for its southern boundary.

The drainage is all southward into Tunkhannock by means of Martin's, Horton's, and other creeks; of these, Martin's creek cuts a deep furrow through the rocks and many exposures are seen along its banks and in the cuts of the D., L. & W. R.R.

The rocks of this area belong wholly to the *Catskill system*, and are composed of alternate beds of greenish gray current-bedded sandstones, and red shales, with occasional layers of *calcareous breccia.*

Near Foster station, a ledge of sandstone 10′ thick is seen on the west bank of Martin's creek, with its base at 890′ A. T.; and a short distance below Foster station the same bed of rock occurs in a R.R. cut, where it is reddish-brown, resting on greenish-blue shales.

At Foster the level of Martin's creek is 50′ below the depot, and along its bed some layers of flaggy sandstone and shale are seen cropping out.

In descending from the summit of the hills east from Foster, the following is seen:

Foster section.

1. Cliff sandstone,	75′
2. —— Concealed,	100′
3. Sandstone,	50′
4. —— Concealed,	50′
5. *Red shale*, seen,	10′
6. Sandstone, massive,	20′
7. —— Concealed,	75′
8. Sandstone to R.R. level (890′ A. T.,)	10′

No. 1 makes a long high cliff along the summit of the ridge, and is a mass of greenish gray current bedded sandstones in layers 2′ to 10′ thick, and these are often finely laminated. A great pile of talus lies around the foot of the cliff, broken away from the rocks above.

No. 2 is quite massive, and also makes a line of cliffs along the hill just opposite Foster station.

No. 6 occurs in the hills just above Foster where it too, forms a bold cliff outcrop.

About one half mile below Foster, 25′ of greenish gray current bedded sandstone is seen in a R.R. cut, and there the following is exposed:

1. Sandstone,	25′
2. *Calcareous breccia,*	3′
3. Greenish blue shale,	½′
4. *Red shale,*	2′

No. 2 is a dark impure *lime rock* filled with chips of slate of an olive green cast, and also many fragments of what was apparently an older limestone; *fish bones* also are present, these last being in small fragments and weathering to a bluish white on exposed surfaces. The fragments of shale have evidently been derived from the underlying bed by its erosion previous to the deposit of the limestone.

Occasional layers of *calcareous brecciae* are seen in No. 1, but they are merely local and soon disappear when followed for any distance along the face of the cliff.

Just below the locality of this section No. 2 is seen thickening up to 5′ and it weathers to a black rotten mass on exposed surfaces.

One mile below Foster, and just opposite Bell's mill, the following section is seen in descending from summit of hill on the east bank of Martin's creek:

Bell's Mill section.

1. Sandstone, massive,	40′
2. —— Concealed with an occasional show of red shale,	30′
3. Sandstone,	40′
4. —— Concealed,	30′
5. Sandstone,	30′
6. —— Concealed,	100′
7. Sandstone,	20′

8.	—— Concealed,	80′
9.	Sandstone,	20′
10.	—— Concealed,	40′
11.	Sandstone to track level (870′,)	5′

Nos. 1, 3 and 5 make perpendicular cliffs of gray, current-bedded sandstone around the summit of the hill, and also contain irregular layers of *calcareous breccia*, many massive *bowlders* of which are scattered over the ground. One of these layers in No. 3 seems to be quite presistent.

Nos. 5, 7 and 9 also make lines of cliffs in the bluff, and are all greenish-gray, current-bedded sandstones.

No. 9 has a layer of very heterogenous material at its base, 5′ to 6′ thick, consisting of a conglomerate *mass of shale*, *pieces of sandstone*, *breccia of lime*, &c. This is the stratum which occurs in the Foster section with its top 105′ above R.R. grade (890′ A. T.,) thus showing a *dip* southward of 60′ per mile at this locality.

Just south from here another cliff sandstone is seen extending down to the level of Martin's creek 30′ below R.R. level. It is most probably the same one seen near R.R. grade at Foster.

As we pass on down Martin's creek, No. 9 approaches R. R. grade more and more, and where the country road crosses the track two miles below Foster its base comes down to the level of the same (at 850′ A. T.,) thus giving a *dip* of 65′ southward in the mile between this point and Bell's mill.

Just at the southern line of this township and one half mile above Nicholson (in Wyoming county,) the base of a very massive ledge of sandstone is seen at 250′ above R.R. or 1026′ A. T. ; directly below it are seen 3′ of red shales. The base of this cliff strikes on a level with a cliff-rock 40′ to 50′ thick seen in a long outcrop on the opposite or western side of Martin's creek.

The following section is seen at Nicholson and is inserted here because it is so near to this township :

Nicholson section.

1.	Sandstone, massive,	15′
2.	*Calcareous breccia,*	6′
3.	Sandstone, (base at 995′,)	10′
4.	*Red shale,*	30′

5. —— Concealed,	80′
6. Sandstone, massive,	10′
7. —— Concealed,	30
8. Sandstone,	15′
9. —— Concealed,	15′
10. Flaggy sandstone,	10′
11. —— Concealed to R.R. level (766′ A. T.,)	40′
12. —— Concealed,	20′
13. Massive sandstone to level of Martin's creek,	20′

Nos. 1, 2 and 3 very probably represent the massive rock with *calcareous breccia* seen at 1195′ A. T. in the section at Bell's mill (Fig. 51) one mile below Foster, since this would give a *dip* of (1195′—995′)=200′ in the 3½ miles south, or about 57′ per mile, which is about what we have found for the fall of the rocks between Foster and Nicholson.

The *calcareous breccia* imbedded here between two masses of sandstone, seems to be continuous at this locality, and great blackened *bowlders* of it lie scattered over the surface below. It is most probably the parent bed of the same class of bowlders that are found constantly along Martin's creek valley between Nicholson and Foster.

The shale below is dull-red and somewhat sandy.

Flagstone Quarry.—The flaggy sandstone 40′ above R. R. level is extensively quarried at Nicholson, and furnishes very smooth flagstone of a greenish-gray color and 2″ to 4″ thick.

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26. Springville, in Susquehanna county.

This lies directly west from Lathrop and has Wyoming county for its south boundary.

The drainage is all southward by way of Meshoppen and White creeks directly to the Susquehanna river.

The rocks of the township are about the same as those found in Lathrop, to the east, and all belong to the *Catskill series.*

The sandstones of this system are frequently seen forming cliffs in the hill, but as no streams cut very deep channels through the rocks, the exposures are poor and nothing like a section can be obtained.

Barometric elevations in Springville.

	A. T.
Forks near J. Rosengrant's,	1090′
Cross roads at Rosengrant's School House,	1200′
Forks near L. Scott's,	1160′
" D. Thomas's,	1120′
Forks one half mile south,	1100′
Forks near F. L. Fish's,	1170′
" L. S. Taylor's,	1210′
Cross roads in Lynn P. O.,	1210′
Forks near E. B. Lyman's,	1150′
Cross roads at Lymansville School House,	1150′

27. Auburn, in Susquehanna county.

This lies immediately west from Springville, has Wyoming county on the south, while Bradford bounds it on the west. The township thus occupies the southwest corner of Susquehanna, and extends in that direction nearly to the Susquehanna river.

Its entire area drains southward and westward into the Susquehanna by way of several small streams, among which are White, Riley, Little Meshoppen, Pochuck, and Tuscarora creeks.

The rocks belong to the *Catskill system* though in the extreme western portion the westward flowing streams cut down nearly to the top of the *Chemung.*

The sandstones of the *Catskill* form many cliffs in the hills of this township but no continuous exposures are to be found.

At the north line of the township, near Mr. Benj. Canfield's, a massive sandstone is seen capping a hill at 1500′ above tide ; it may possibly belong to the *Montrose series.*

At Harris's mill a *flagstone quarry* is wrought at 1200′ A. T. the flags are greenish-gray, 2″ to 4″ thick.

Below the quarry 60′ a massive current-bedded sandstone is seen down near creek level.

Glacial striae going S. 55° W. are seen one mile west from Harris's mill, near Mr. P. Reynold's.

In the southwestern corner of the township, and just west of it in Bradford county several *flag quarries* have been opened in the lower members of the *Catskill sandstone series* principally in the *New Milford Lower S.S.;* one of these near Laceyville has an elevation of 200′ above R.R. there or (658′+200)=858′ A. T.

Just below Laceyville on the east bank of the Susquehanna may be seen a vertical cliff of *Catskill rocks* 200′ in height, and the *New Milford Lower S.S.* occurs near the top.

Fossil plants.—At the flag quarries we often see many fragments of vegetable remains broken and macerated beyond identification.

Along the stream which enters the Susquehanna at Laceyville we see many fossil *shells* of *Chemung* type coming in about 150′ below the *New Milford Lower S. S.*

Barometric elevations in Auburn.

	A. T.
Forks near J. M. France's,	1470′
" Benjamin Canfield's,	1465′
" J. E. Hibbard's,	1430′
Level of Riley creek near Harris's mill,	1125′
Forks west of J. Murtaugh's,	1330′
Forks near Mrs. R. Black's,	1260
" Bennett's hotel,	1360′
Cross roads in Auburn Center,	1390′
Forks near I. Scott's,	1440′
" John Carlin's,	1050
Level of Little Meshoppen near by,	1000′
Forks near Caldwell McMicker's,	1300′
Cross roads in South Auburn P. O.,	1200′
" near D. Dornblauser's,	1140′
Forks near N. Baldwin's,	1125′

28. Scott, in Wayne county.

This township occupies the extreme northern portion of Wayne, being bounded on the west by Susquehanna county, north by Sullivan county, New York, east by the Delaware river, thus extending entirely across the north line of the county.

Trending north and south through this area, in a very irregular line, is a high divide ranging from 1800′ to 1900′ A. T. The N. Y., L. E. & W. R.R. (Erie) crosses this same divide through a low glacial gap at the Summit Cut in New York, five miles north from the township line. The R.R. *cut* is about 150′ in depth. The elevation of the track 1376′ A. T. The neighboring hills on either side rise 400′ to 500′ higher.

This high divide enters the township at its north-western corner, and passes south-eastwardly into Preston. From its eastern slope the rain-fall drains eastward into the Delaware river, by several small streams; while that from the western slope goes off westward into the Starrucca creek and the Susquehanna river.

The rocks of this area belong entirely to the *Catskill system*, since none of the water ways cut down to the *Chemung*, though at the north line of the township, on the Delaware, the top of the *Chemung* does not lie more than 200′ below drainage level.

The highest stratum of any considerable extent, occurring in the section is the *Honesdale Lower sandstone*, which occurs along the summit already refered to in long lines of grayish white cliffs, attaining at the north line of the township an elevation of 1850′ A. T. This I know to be the *Honesdale sandstone*, because I have traced it continuously northward from Honesdale into Scott township; the task is not difficult, for it is the first rock found in ascending through the *Catskill* from the *Chemung*, that makes any approach to whiteness in color, being quite massive in addition. It thus becomes a conspicuous landmark in the geology of Wayne county, since it can be followed by the the eye from cliff to cliff and from hill to hill. At Honesdale its base has an elevation of 1225′ above tide, thus making a northward rise of (1850′—1225′)=625′ in the 30 miles between Honesdale and the north line of Scott township, or at an average *rate* of 21 feet per mile.

At the south line of the township near the edge of Starrucca borough the *Honesdale Lower sandstone* is seen making a line of massive cliff outcrop around the hills; elevation at base 1700′ A. T.

On the summit of the hill, one mile south from J. Myrick's school-house, the outcrop of a massive grayish white sandstone is seen at 1900′ A. T.; it represents one of the massive sandstones that are often found in connection with the *Cherry Ridge limestone*; below it 50′ is the outcrop of a gray sandstone not so massive as the upper.

About one half mile east from J. L. Putnam's, at the western line of Scott, we find a long high ridge capped with the *Honesdale Lower sandstone* at an elevation of 1825′ A. T. Descending from the summit the following succession is observed:

Putnam's section.

1. Sandstone, grayish white, *Honesdale Lower*,	35′
2. —— Concealed,	40′
3. Sandstone, massive,	20
4. —— Concealed,	200′
5. Grayish green sandstone,	25′
6. —— Concealed with occasional outcrops of S.S. to base of *Catskill S.S. series*, on Starrucca creek, Susquehanna county, 3½ miles west,	515′

In No. 6 are many beds of greenish-gray massive sandstones; and at the base, near Steven's Point on Starrucca creek, we find the *New Milford Lower sandstone*, a dark greenish gray stratum making excellent *building stone.*

From an inspection of the section it will be seen that the *Honesdale sandstone* comes 800′ above the *New Milford Lower sandstone*, or 1000′ above the base of the *Catskill system.*

Barometric elevations in Scott.

	A. T.
Forks near southern corner of township at H. Wayman's,	1690′
“ J. B. Lake's,	1600′
“ J. Gardineer's,	1325′
“ J. L. Putnam's,	1425′
Cross roads near B. C. Farrell's,	1790′
“ J. Myrick's,	1825′
“ A. M. Early's,	1520′
Forks near S. E. Stanton's,	1840′
Level of pond just west,	1800′
Forks near H. Winter's,	965′
“ B. S. Faulkner's,	1005′

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29. *Preston, in Wayne county.*

This lies south of Scott, and adjoins Susquehanna county.

This area is the culminating point of Wayne county, since the general elevation of the highlands is near 2000′ above tide, while such peaks as Sugar Loaf and Ararat rise 500′ to 600′ higher. It thus becomes a common heading ground for many streams that flow in quite different directions, the eastern and southern portions draining into the Delaware river by way of Chehocton, Equinunk, and Lackawaxen creeks, while the north and west drain into the Susquehanna by way of Starrucca creek and the Lackawanna river.

Another feature quite noticeable to any one who will glance at a map of this area is the great number of ponds and lakelets scattered throughout the entire township.

There are no less than 20 of these ponds or lakelets in this township, some covering only 2 to 5 acres, while others like Big Hickory pond, extend over an area of 50 to 75. The depths of several have been determined by Hon. N. F. Underwood of Lake Como, and kindly placed at my service, for an account of which see Introductory Part.

The two most conspicuous objects in this township are Sugar Loaf and Ararat mountains, two peaks near its southwestern corner that tower 500′ to 700′ above the surrounding plains. The former has an elevation of 2450′ A. T. as determined by barometer, and the latter 2600′, being therefore the highest summit in the county and most probably the second highest in the northern portion of the State; North Knob in Susquehanna county being 100′ higher.

These elevated summits, capped with massive rocks, are due entirely to erosion. They are on the line of the Moosic mountains and seem to terminate the northern extent of that range, since after we pass these no general line of elevation can be followed to the northward, except the high dividing ridge which extends through Scott and passes into New York across the line of the Erie R.R. at the summit cut.

These summits, which probably existed as elevated hills in pre-glacial times, were left as islands in the ice moving southward and escaped the universal abrasion to which every other portion of the township was subjected; for no appearance of Drift or Glacial scratches can be found on their sides or summits.

The rocks of this area belong entirely to the *Catskill system*, unless we except the massive gray sandstones which come near the summit of the two elevated peaks just mentioned. It all depends on what rocks we consider as the base of the *Pocono;* if the *Mt. Pleasant Conglomerate* be taken as the base, then there are 300′ of *Pocono* on the top of Ararat peak; but if the *Pocono* should properly begin with the *Griswold's Gap Conglomerate*, 400′ higher, then all the rocks of the township belong to the *Catskill.*

The surface is very rough and uneven and countless bowlders of sandstone and *calcareous breccia* lie scattered over it in every direction.

In descending from the summit of Sugar Loaf the following succession is exposed: (Fig. 44.)

Sugar Loaf section.

1. Summit capped with gray sandstone (2450′ A. T.,) . . .	20′
2. —— Concealed with many massive S.S. beds in interval, .	120′
3. Sandstone with *calcareous breccia* at base, ...	10′
4. —— Concealed, ...	50′
5. *Mt. Pleasant Conglomerate*, ...	25′
6. —— Concealed, ...	130
7. Sandstone, pebbly, (base 2075′ A. T.,)	20′

The *Mt. Pleasant Conglomerate* is a coarse massive rock, and contains at its base a *calcareous layer* filled with quartz pebbles, the most of which have a red or rose-colored tinge. These reddish pebbles characterize this stratum of rock at South Knob on Elk Mt.

Just west of Preston P. O. the outcrop of a *calcareous breccia* is seen, and immense black *bowlders* of it are scattered over the hill at an elevation of 1560′ A. T.; just south of the village, another ledge of the same material is seen at 1600′, they may possibly represent the *Cherry Ridge group.*

Near Decker school-house 2 miles north from Lake Como, the following is seen:

Decker S. H. section.

1. Sandstone, grayish white, (*Honesdale Upper*,)	30′
2. —— Concealed,	20′
3. Red sandstone,	25′
4. —— Concealed,	50
5. Grayish white sandstone, (base 1450′ A. T.,)	25′

This section represents the *Honesdale sandstone series*, since No. 1 is the white sandstone which has been traced continuously northward from Honesdale. The *red sandstone* is very characteristic, being the only red sandstone in the *Catskill series* of Wayne county, all the other red rocks being shale; it is finely laminated, and very hard, so that *bowlders* of it are of frequent occurrence in the *Drift*.

About two miles due west from the locality of this section and near Tallmanville the outcrop of the *Cherry Ridge limestone* is seen at 1800′ A. T. huge masses of it lie scattered over the ground and are very black on their weathered surfaces; fragments of *fish bones*, shale, and other material occur in it abundantly; the stratum probably contains 20 to 30 per cent. of lime.

Barometric elevations in Preston.

	A. T.
Summit of Ararat mountain,	2600′
" Sugar Loaf,	2450′
Hines's Corners,	1980′
Forks at N. R. Ray's,	1925′
Cross roads near J. L. Hubbard's,	2000′
Level of Wrighter's pond,	1950′
" Coxtown pond,	1950′
" Independent pond,	1950′
" Bone pond,	2000′
Cross roads near W. Lee's,	2050′
Forks near D. M. Knapp's,	2000′
Level of pond just east,	1960′
Forks near D. M. Benedict's,	2020′
Forks at Preston Center School House,	1980′
Forks near C. B. Dibble's,	2000′
Forks next north from A. D. Reynolds's,	1900′
Cross roads in Tallmanville,	1740′
" at Stanton School House,	1840′
Forks near S. T. Whittaker's,	1435′
Cross roads at J. W. Decker's,	1540′
Level of Lake Como,	1475′
Cross roads at Como P. O.,	1495′
" near W. Kerr's,	1725′
Forks near O. A. Lakin's,	1815′

Level of Big Hickory pond,	1950′
Forks near C. F. Bryant's,	2025′
“ T. Leonard's,	2010′
“ T. McKee's,	1950′
Cross roads near M. Monnaton's,	1690′
Forks near Mrs. Mosier's,	1500′
Level of Equinunk creek north of Preston P. O.,	1475′
“ road at N. F. Underwood's,	1620′
Forks near C. B. Sherwood's,	1505′
“ P. Madigan's,	1365′
“ J. McGrath's,	1375′
Forks next west,	1375′
Forks near Mrs. B. Riley's,	1500′
“ P. Tully's,	1530′
“ B. M. Wilcox's,	2040′

30. Buckingham, in Wayne county.

This township has for its western boundary Scott and Preston, while on the east it borders the Delaware river for several miles; it is a very long, narrow and irregular area, having a remarkable similarity in general shape to Wayne county as a whole.

The entire surface drains into the Delaware river, and the water is mostly carried off by small streams which head only three to four miles back on the highlands and descend with a very rapid fall.

The rocks of the township belong entirely to the *Catskill.*

About two miles east from Lake Como the outcrop of a massive sandstone is seen at 1500′ A. T., and above it on the opposite side of the valley near G. W. Sherman's, there occurs a great *cliff* of whitish sandstone, whose base comes at 1600′. This most probably represents the *Honesdale Lower sandstone* since it is found nearly due west from this in Preston at about the same elevation; the sandstone is not naturally whitish, but becomes so only on its bleached or exposed surfaces: on fresh fracture it is generally grayish-brown with much oxide of iron interspersed; but when exposed the iron is leached out, and the sandgrains decolorized.

In passing from Sherman's eastward to the Delaware, we go down over a continuous succession of current-bedded, grayish-green sandstone, and red shales for 800′, and then do not reach the base of the *Catskill sandstone series.* Hence these rocks must be increasing in thickness quite rapidly toward the southeast from the northern line of this county; since at the western line of Scott township a nearly vertical measurement gives only 800′ from the base of the *Honesdale Lower sandstone* down to the base of the *New Milford series.* But here on the Delaware, at Dillon's mill, the same interval must be more than 1000′, because the *New Milford Lower sandstone* comes down to the level of the Delaware, 12 miles above, and the dip cannot be less than 20′ per mile.

Barometric elevations in Buckingham.

	A. T.
Forks near Ball's Eddy at Mrs. Smith's,	960′
" H. Geer's,	975′
" J. Jones's,	925′
Forks next above on Chehocton creek,	965′
" from J. G. Squire's,	1210′
Forks near G. E. Falling's,	1325′
" W. G. Underwood's,	1410′
Level of pond near by,	1400′
Road at Jericho School House,	1425′
Forks next north,	1550′
Forks near R. Randall's,	1560′
Level of road at crossing of stream next east,	1190′
Forks near Adams' lake,	1320′
Crossing of stream at C. P. Waller's,	1370′
Forks near W. Brown's,	1435′
Level of North Equinunk near Knight's mill,	1325′
Forks near Mrs. E. Wyckoff's,	1260′
Level of North Equinunk near L. Henkley's,	1120′
Forks near J. C. Branning's,	1090′
Level of Equinunk at L. S. Jump's,	1010′
" M. McKinney's,	925′
Forks near T. Tyner's,	900′
Forks next north-east,	890′

31. Manchester, in Wayne county.

This lies east from the south-eastern line of Buckingham, being separated from it by Equinunk creek, while the Delaware river bounds it on the north and east; the Delaware also receives the entire drainage of the district, through Equinunk and Little Equinunk creeks.

A large portion of this township is still in the original wilderness, being covered with forests of hemlock, which in many places are almost impenetrable because of the thick growth of underbrush.

Along the Delaware the scenery is often quite wild the massive gray and green sandstones of the *Catskill series* being frequently seen in great *cliffs* which rise in succession one above the other.

The rocks of the township belong exclusively to the *Catskill series.*

Notwithstanding this fact several parties have been actively searching after gold mines for a number of years, and have already spent a small fortune in the fruitless task. One of these localities is on the land of Mr. Lord 2½ miles north of Priceville. Here a California miner has been digging and shafting for two or three years, and holding out such hopes of gain to the proprietor of the land that he has thus far been enabled to secure free lodging and considerable money besides. Some of the reputed *gold* was shown me, which was nothing but specks of mica discolored by by iron in a matrix of sandstone—one of the common greenish gray sandstone of the *Catskill series.*

In the hills at Equinunk and about 200′ above the Delaware river a great mass of sandstone juts out of the hill and is seen in successive beds on each side of the river up to 350′ above the same; some are grayish white, others are greenish gray and all exhibit much current-bedding; the same group of rocks is seen circling around the hills for a long distance down the Delaware.

In the south-western corner of the township the hills rise to 800′ above the level of the Delaware and catch the *Honesdale sandstone* in their summits; it is seen in cliffs, and is also strewn over the ground in large masses broken away from the original bed.

Barometric elevations in Manchester.

	A. T.
Forks near G. Lord's,	950′
" J. Andrews's,	960′
" W. Taylor's,	890′
" L. W. Hawkins's,	1530′

Forks near E. Lord's,	1415′
" H. Braman's,	1065′
" John Bloom's,	1075′
Level of Little Equinunk next south,	1065′
Forks near N. Groom's,	1070′
Cross roads near J. Myers's,	1170′

32. Damascus, in Wayne county.

This township lies directly south from Manchester and like it has the Delaware river for its entire eastern boundary.

The Delaware drains the entire district, principally through Calkin's creek which empties into it at Milanville.

This township like many others in Wayne, contains several small lakes, or ponds, and one of these in the northwestern portion of the township called Duck Harbor is of considerable size; it lies partly in Damascus and partly in Lebanon, and contains an area of about 175 acres.

The rocks of this area belong entirely to the *Catskill series*, the top of the *Chemung* lying probably three to four hundred feet below river level on the Delaware.

All along this river, the *cliff sandstones* of the Catskill are seen in bold escarpments lining either bank of the stream with immense *cliffs* of massive gray rock, with much current bedding; outcrops of *blood red shale* frequently intervening.

Sometimes the channel of the river narrows and the cliffs on opposite sides of the river approach very close to each other. They sometimes pass in massive beds across the channel of the river, making falls or rapids in its course.

Narrowsburg, N. Y., just at the southeastern corner of this township, is so named from the fact that owing to an unusual massiveness in the rocks at that point the channel of the river narrows up or contracts to so small a compass that a wooden bridge unites the opposite shores with only a single span of 160 feet, whereas the usual breadth of the Delaware is about three times as great.

The *Honesdale sandstone group* is found on the highest summits, about 1500′ A. T. One of these localities is in the northwestern corner of the township, one mile and a half south-east from Duck Harbor lake, on the land of Mr. Rutledge, where the following succession occurs: (Fig. 45.)

Rutledge section.

1. *Honesdale Upper sandstone*, massive, white, ...	50′
2. *Red sandstone*, ...	35′
3. *Honesdale Lower sandstone*, ...	20′
	105′

The base of the *Honesdale Lower sandstone* comes 1510′ A. T. The rock is brownish gray on fresh fracture, but on its weathered surface is very whitish, with occasional small black specks; the whitish color being due to a removal of the iron by atmospheric action.

No. 2 is the same peculiar *red sandy* material that we constantly find at this horizon; it is almost too fine in grain to be called a sandstone, and yet it is so gritty and hard that by no stretch of fancy could it be termed a shale.

No. 1 is very massive, and seems divided near its center by a thin band of shale into two beds; this is not seen at the locality of the section, but on the opposite side of the valley. Here the whole series is exposed in a steep bluff.

Where the county road crosses the outlet of Duck Harbor lake, the stream makes a fall of 20′, over a massive gray sandstone, whose top is 1315′ A. T.

The *Honesdale group* is seen five miles south from Rutledge's extending along both sides of the south branch of Calkin's run; the *upper sandstone* having an elevation of 1480′ A. T. Far up in the hills above we see another massive sandstone with an *impure limestone* at its base 5′ thick; this is at an elevation of 1615′ A. T., 135′ above the base of the *Honesdale Upper sandstone*, (approximately) 200′ above the base of the *lower one*, and is therefore the *Cherry Ridge limestone;* it is seen in large black bowlders scattered over the hill tops in every direction; on fresh fracture this rock is seen to consist of a conglomerate mass of *pieces of shale*, *pebbles of sandstone*, and immense quantities of what appears to be *fish bones*, very much broken and worn, all cemented into a matrix of calcareo-siliceous material, of which probably 20 to 30 per cent. is calcium carbonate.

Just west of Tylerville a band of *calcareous conglomerate*, 2′ thick, is seen about four hundred feet below the last.

Just across the Delaware river, on the New York side, at Narrowsburg, a hole was once bored for oil to a reported depth of 800′; its top was on the bluff about 25′ above the channel of the stream. No record could be obtained of it, and very contradictory statements were given me concerning its depth; all that can be safely asserted, is that some gas was struck at an uncertain depth, since all the reports agree in this. If the well were really drilled to a depth of 800′ it must have penetrated the *Chemung rocks* to a considerable depth unless the *Catskill* greatly thickens southward.

As we pass westward from Narrowsburg up on to the highlands, many bold outcrops of massive cliff sandstones occur. One, more massive than usual, is seen near Branningville with its base at 1015′ A. T.; it is grayish-white in color and about 30′ thick.

Further east from Branningville, we see the same stratum 45′ thick, and above it (at 1105′ A. T.) we see the base of a coarse gray sandstone, in which occur many small angular pebbles of white quartz.

West from this near J. Sprook's we see a cliff sandstone beginning at 1375′ A. T. and extending up to 1425′ at the summit of the hill.

Barometric elevations in Damascus.

	A. T.
Level of Duck Harbor pond,	1350′
Level of outlet of D. H. P. at road crossing east,	1285′
Forks near E. Rutledge's,	1365′
" J. Quarles's,	1335′
Level of run near J. L. Rutledge's,	1250′
Forks near J. Avery's,	1300′
" S. Pethick's,	1265′
" J. Jackson's,	1355′
" R. Alfast's,	1315′
Level of Laurel lake,	1265′
Cross roads in Tylerville,	1110′
Level of North Calkin's creek at H. C. Manington's,	920′
" " ½ mile below B. Bedient's,	865′
Forks near A. Sherwood's,	820′
" W. Skinner's,	765′
Forks north from F. Miller's,	800′

Level of run at P. Wilbert's,	950′
Forks near D. Brown's,	1100′
" A. Wood's,	950′
Forks in Branningville,	980′
Forks near W. D. Guinnip's,	1035′
" F. Eberspacker's,	1115′
Forks west from J. Lovelace's,	1210′
Forks east from W. H. Gavitt's,	1185′
Forks at Eldred P. O.,	1150′
Forks near J. W. Goodall's,	1345′
" O C. Mitchell's,	1430′
" J. Bartlett's,	1305′

33. Lebanon, in Wayne county.

This lies directly west from the northern half of Damascus having Manchester and Buckingham townships on the north.

The greater portion of this township is a perfect wilderness, once covered by dense forests of hemlock, but these have largely disappeared through the activity of the tanneries, and the new forests are a perfect tangle of vegetation through which it is almost impossible to penetrate.

Many of the roads are mere byways filled with *bowlders* of every size, over which one cannot drive a vehicle at a greater speed than two miles per hour. With the exception of the Moosic Mountain region it is probably the roughest portion of Wayne county.

The northern portion is very high, forming a drainage summit; while from almost any point in the township the blue outline of the *Catskill Mountain*, one hundred miles away, can be seen looking like dense cumulus clouds low down in the horizon.

Near the northeastern corner of this township, is a very elevated peak called Big Hickory Knob, rising 400′ to 500′ above much of the surrounding country. An attempt was made to reach its summit and determine its elevation as accurately as is possible with a barometer; but the geologist got lost in the seemingly endless forest where numberless "bark-roads" lead in every direction, and having been benighted in one attempt to reach its summit, was thereafter content to estimate its height from the top of adjacent peaks of known elevation three miles away ; the result of this estimation makes the summit of the knob 2250′ A. T. and I feel safe in asserting that this cannot differ more than 100′ from the true elevation.

That a peak of this kind should be left towering 400′ to 500′ above all the surrounding country, is sufficient evidence of the vast amount of rock material that has been worn away from the surface of Wayne county by erosion.

It is only about eight miles away from the Delaware river, and yet it rises 1500′ above the channel of that stream.

The strata on the eastern side of the Delaware are continuous with those in Big Hickory knob. It follows that the Delaware river has cut its channel down through at least 1500′ of rock strata ; and very probably quite as much more has been worn away above the summit of Big Hickory knob, which, as an island surrounded by the ice, escaped erosion and retained pre-glacial elevation. While the Drift is abundant on all sides of the knob, it entirely disappears as we approach its summit.

Little Hickory knob lies about three miles northwest from Big Hickory but does not reach to so great an elevation by about 250′ or 300′.

The drainage is mostly southward into the Dyeberry, which empties into Lackawanna at Honesdale, though the the north-eastern corner sends its water through Duck Harbor pond off eastward to the Delaware by way of Little Equinunk.

The head-waters of the Dyeberry in this township, have been dammed up by the Delaware and Hudson Canal Co., and form large ponds in which the surplus water is stored during rainy weather, and gradually let out to supply the canal during seasons of drouth. The company has three such ponds in this area, viz: *Upper Woods*, *Lower Woods*, and *Rose*.

The rocks of this area belong entirely to the *Catskill series*.

Just west from Rileyville the base of the *Honesdale*

Lower sandstone is seen at 1475′ A. T., quite massive, and it makes a great cliff around the hills.

About two miles north from where the Newburg turnpike crosses the East Branch of the Dyeberry, the *Honesdale Lower sandstone* is seen; its base 1495′ above tide. Between Big Hickory and Little Hickory knobs, a great gap has been cut, from the northern edge of which the drainage goes northward into Equinunk creek. The evidence of *glacial action* is everywhere visible along this gap in huge piles of morainic débris, and in the scratched and polished surface of the outcropping rocks; general direction of striae S. 5° to 10° W. magnetic.

Near H. Kesler's, on the Newburg turnpike, some massive sandstones appear along the road, and their exposed upper surfaces are scored with *glacial* markings in long parallel striae going S. 5° W., elevation 1635′ A. T.

At this same locality we also see the outcrop of a black *calcareous conglomerate* at 1640′ A. T. and it may possibly represent the *Cherry Ridge limestone*, since it has a thickness of 5 feet.

Near the northern line of the township, and just west from the Upper Woods Pond, a whitish sandstone is seen covering the surface with *immense bowlders* many of them being larger than a good sized house. The base of the stratum appears to come about 1575′ A. T. and is therefore most probably one of the *Honesdale group*.

Barometric elevations in Lebanon.

	A. T.
Forks at south-east corner of township near H. Eyer's, .	1670′
Forks near H. Tamlin's, ...	1635′
" H. Dennis's, ...	1615′
" C. Rice's, ...	1560′
" J. E. Taylor's, ...	1640′
Cross roads in Rileyville, ...	1715′
Forks near P. McGuire's, ...	1590′
Level of Dyeberry (E. Br.) near S. Yates', ...	1340′
Cross roads near C. H. Scudder's, ...	1600′
Forks of road near P. McKenney's, ...	1590′
Top of Big Hickory Knob, ...	2250′±
" Little "	2000′±

34. Mt. Pleasant, in Wayne county.

This lies immediately west from Lebanon and extends to the Susquehanna county line for its western boundary. The Moosic Mountains extend north and south along its western border and in many localities the surface is quite as wild and rough as in Lebanon.

The drainage is nearly all southward by way of the Lackawaxen, and its principal tributaries Johnson and Dyeberry creeks. A small portion of the rainfall however, at the extreme western line of the township, on the western slope of the Moosic Mountains, passes westward into the Lackawanna river and thence into the Susquehanna system.

Near the sources of many of the streams are wide level stretches of marsh and pond; these have been dammed in and the accumulated waters stored up for the use of the D. & H. canal.

Belmont Lake is the largest of these, and is situated at the northwestern corner of the township.

Much of the land in the western half of this area has a great elevation, ranging at the summits of the hills from 1900′ to 2000 feet A. T. while at the extreme western line some peaks of the Moosic chain rise to 2100′ and upwards.

The rocks of the township belong to the *Catskill series*, except along the elevated region of the Moosic highlands at the western line of the county, where the lower portion of the *Carboniferous formation* occupies the summits of the highest peaks.

Along the western edge of this township we see in many places large blocks of a very curious conglomerate, and at one locality it occurs *in situ;* this is on the summit near the old school-house in the village of Mt. Pleasant, where it covers about ½ acre of ground at an elevation of 2025′ A. T. From its occurrence here I have termed it the *Mt. Pleasant Conglomerate.* The matrix is a dark coarse sand and is filled with numerous angular, white and reddish quartz pebbles, usually about the size of a chestnut; occasionally we find a *calcareous layer* near its base, of a greenish gray color, also full of quartz pebbles. This is apparently identical with the great cliff rock at Prospect View on Elk mount-

Fig. 43.
South Knob.

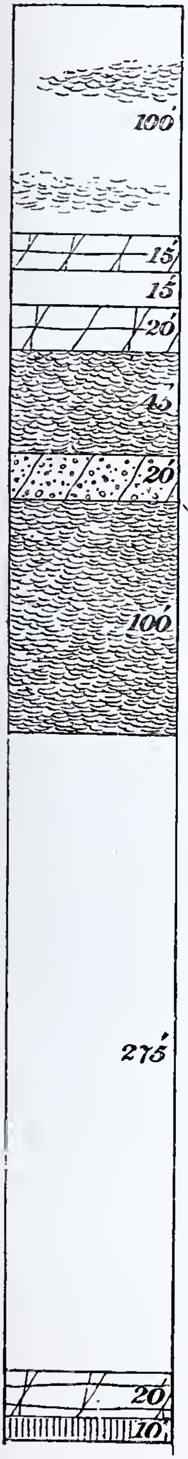


Fig. 44.
Sugar Loaf.

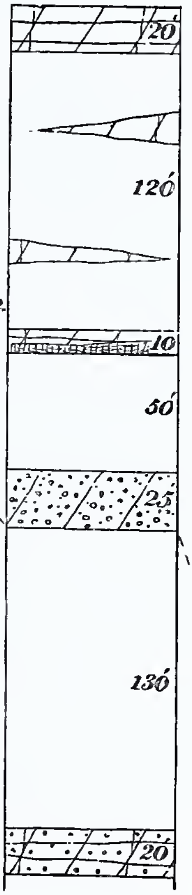
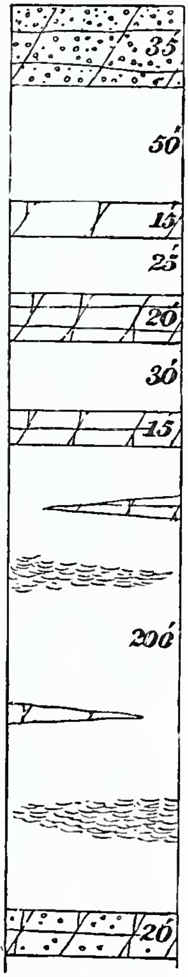


Fig. 48.
Moosic Mtn.



G5.

ain, Susquehanna county, since it comes about 350′ above the horizon of the *Cherry Ridge limestone.*

The Mt. Pleasant rock has been mistaken by many local geologists and miners for the *Seral Conglomerate* of Rogers, and many have been led to believe that the coals of the Carbondale series should be found in the hills above it, or at least in such elevated peaks as Ararat and Sugar Loaf mountains, a few miles to the north. But this identification is founded only on the *conglomeratic* character of the rock, and makes no account of the dip or structure. It will probably be a surprise to many people to be told that the *Mt. Pleasant Conglomerate really lies 1200′ below the Seral Conglomerate* and 1400′ below any valuable beds of coal. Such is nevertheless the condition of affairs. In other words the Mt. Pleasant hills could not possibly hold any *workable coal beds* unless they were about 1500′ higher than now.

It may be some consolation to be assured that in all probability these hills did once reach such an elevation, and also contained coal, but the ceaseless forces of erosion have, since the close of the Carboniferous Age, worn away all of this 1500′ and possibly much more; so that it is an absolute waste of time and energy for any citizen of Mt. Pleasant township to bother himself about the presence of *coal* in these hills.

Immediately below the *Mt. Pleasant Conglomerate* is a great bed of almost blood red shale; it is seen in passing down the hill just west of Mt. Pleasant; and from this locality I have termed it the *Mt. Pleasant red shale* since it seems to be quite persistent at this horizon. The thickness of red material exposed at Mt. Pleasant is about 150′ and in this interval only two or three sandy layers are seen.

About two miles south from Mt. Pleasant the *Cherry Ridge limestone* is seen outcropping in the hills at an elevation of 1600′ A. T., and still further to the southwest near Mr. O. Kelley's the hill is covered with large *bowlders* of this material at the same horizon.

One mile south from O. Kelley's, the *Honesdale Lower sandstone* is seen passing below drainage with a slight northern dip at an elevation (at base) of 1400′ A. T. This is near the cross roads at Mrs. Vastbinder's. Going south from this along Lackawaxen creek the outcrop of the *Honesdale sandstone series* is seen almost continuously in a line of cliffs.

One half mile north from the southern line of the township, and near Mr. N. Haunstein's, the following section was obtained on the right bank of the stream: (Fig. 46.)

Haunstein's section.

1. Sandstone, massive, gray, (Honesdale Upper,) visible, .	10′
2. —— Concealed with red SS. at base, ...	40′
3. Sandstone, grayish white, *Honesdale Lower*, ...	30′
4. —— Concealed, ...	15′
5. Sandstone, massive, visible, ...	10′
	105′

No. 3 I know to be the *Honesdale Lower sandstone*, because I have followed it continuously northward from that locality to this, by means of an almost unbroken line of cliff outcrop along the hills; the stratum is rather coarse, grayish white and its top is quite *red*, indicating the nature of the 40′ concealed stratum just above; elevation of base 1410′ A. T.

At Fowler's mill, 1½ miles south from Mt. Pleasant, Lackawaxen creek makes a fall of 20′ over a *red sandstone*, and *shale;* while just above, we see a massive, greenish-gray sandstone beginning at 1735′ A. T.

In the northeastern portion of the township, many outcrops of massive sandstone are seen; and great masses of *calcareous breccia* lie scattered over the hills in every direction.

Near school-house No. 9 the outcrop of a quite massive rock is seen at 1725′ A. T. South of this at A. Conner's we see massive gray sandstones beginning at 1545′ and continuing up the hill to 1630′.

Just south of Rocklake P. O., the base of a white sandstone is seen at 1370′ A. T. This is most probably the *Honesdale Lower*, since one mile further south the base of the *Cherry Ridge limestone* is seen at 1590′; this is just south of W. O. Neil's, and as we go on up the hill a massive sandstone is seen at 1640′ A. T.

Three miles further south and near school-house No. 8, the base of the *Cherry Ridge limestone* occurs at 1520′ A. T. while a massive sandstone occurs in immense *cliffs* for 50 feet further up the hill.

At the very southeastern edge of Mt. Pleasant, where the road crosses the head waters of Dyeberry, the *Honesdale Lower sandstone* is seen making a long white cliff, its top only a few feet above water level, and there the following is seen on the land of Mr. Cramer: (Fig. 47.)

Cramer's section.

1. *Cherry Ridge,*	Sandstone,	28′
	Limestone,	10′
	Red shale,	100′
2. Sandstone, massive,		20′
3. —— Concealed,		80′
4. Sandstone, grayish white, (*Honesdale Lower,*)		30′
		268′

The *Cherry Ridge limestone* and *sandstone* are in immediate contact as usual, and great masses of the former, blackened by the weathering, lie scattered over the hill; it also makes a conspicuous ledge; base 1500′ above tide.

The *red shale* occurs in a very conspicuous band of almost blood-red material along the road which ascends the hill at this locality.

The Honesdale Upper sandstone is concealed in the interval above the *Honesdale Lower.*

Barometric elevations in Mt. Pleasant.

	A. T.
Forks near Lutheran Church at J. F. Wenzel's,	1350′
Cross roads near Mrs. B. Vastbinder's,	1400′
Forks, just south of O. Kelley's,	1475′
" north "	1470′
Level of Lackawaxen creek near J. D. Wheeler's,	1560′
Forks near Fowler's grist mill,	1730′
" E. R. Brown's,	1980′
" F. James's,	2050′
Cross roads near T. L. Mumford's,	2040′
Forks near H. K. Nicholas & Co.'s,	1870
Level of Lackawaxen just east,	1820′
Forks leading north in Mt. Pleasant,	2045′
" south "	2020′
Forks north from P. McCullough's,	1925′
Cross roads near J. S. O'Neill's,	1905′

Forks near J. K. Fulkerson's,	1965′
Cross roads near T. Murphy's,	1535′
Forks next south,	1610′
Summit south,	1760′
Forks at School House No. 9,	1630′
“ next south,	1610′
“ near A. Conner's,	1530
“ next south-west,	1410′
Crossing of Dyeberry next south,	1315′
Forks near W. O'Neill's,	1400′
“ P. O'Neill's,	1490′
“ J. Kelley's,	1540′
“ H. Mills's,	1590′
“ W. Hall's,	1585′
“ M. Kelley's,	1460′
Level of Dyeberry creek near J. Thomas's,	1390′
Forks near M. Doyle's,	1390′
“ next south,	1300′
Crossing of Dyeberry near D. Cramer's,	1270′

35. Clinton, in Wayne county.

This lies directly south from Mount Pleasant, having the extreme southeast corner of Susquehanna on the half of its western boundary, and the *new* county of Lackawanna on the southern half.

The West Branch of Lackawaxen passes south through the eastern portion of the township and drains a very large area of the same, while Lackawanna river flows along its western margin and carries the rain-fall from the western slope of the Moosic Mountains into the Susquehanna at Pittston.

The D. & H. Canal Co. have several large ponds in this township for storing up their water supply, among which are White Oak. Long, and Elk ponds.

The surface of this area is extremely diversified ; in the eastern portion the hill slopes, although often quite steep, are mostly arable, while as we go west the land becomes rougher until we reach the eastern escarpment of the Moosic mountains where all civilization ceases and we enter an unbroken wilderness 2 to 3 miles wide along the western border.

This is the only township of Wayne in which any of the *Coal Measure rocks* occur; along its extreme margin, in the vicinity of Forest City, the great canoe shaped northern end of the *Third Anthracite coal basin* dips down far enough to allow the *Pottsville Conglomerate* to be caught on the western slope of the Moosic mountains, the contour of which conforms to the dip of the *Conglomerate.*

Thus the rocks of this area extend from the base of the *coal measures* down into the *Catskill* including whatever there may be of *Mauch Chunk* and *Pocono.*

Owing to the direction of the principal streams no exposures of these latter formations can be seen in detail anywhere within the township; for on the western slope of the Moosic mountains the tributaries flow directly westward into the Lackawanna river, and thus follow down the descent of the rocks just as fast as the *Conglomerate* dips, but never cutting through it; while to the east the rapid rise of the strata shoots all these measures into the air long before the eastward flowing streams have had a chance to expose them. Hence along the crest of the Moosic the *Mauch Chunk*, and most of the *Pocono measures* come to the surface under great piles of débris which effectually conceal all but the lowest members of the latter.

Griswold's Gap, in the Moosic mountains, lies directly east from Forest City, and west from White Oak pond; it is cut down 200′ to 300′ below the adjoining highlands and a stream passes from it westward into the Lackawanna river.

In descending the eastern escarpment of Moosic from Griswold's Gap the following section is exposed: (Fig. 48.)

Moosic Mt. Section.

1.	*Griswold's Gap Conglomerate*, (base 1975′ A. T.,)	35′
2.	—— Concealed,	50′
3.	Sandstone, massive, gray,	15′
4.	—— Concealed,	25′
5.	Sandstone, grayish-white,	20′
6.	—— Concealed,	30′
7.	Sandstone, gray,	15′
8.	—— Concealed with occasional showings of gray sandstone and red shales,	200′
9.	Pebbly sandstone, (*Mt. Pleasant conglomerate?*) (1700′),	20′
		410

The dip is quite strong (8°—10°) in a western direction or toward Forest City; so that some of the preceding intervals are the result of close estimation.

The Griswold's Gap conglomerate was named from this locality; it is a very hard, coarse whitish stratum, containing vast quantities of snow white quartz in large angular and generally *flattened pebbles* uniformly distributed through the mass of sand. I regard it as certainly a member of the *Pocono* series; elevation of base 1975′ A. T. where first seen at the summit of Griswold's Gap.

Nos. 3, 5, and 7 are all massive, hard, gray, much current-bedded sandstones, and very much resemble the rocks that are seen in the summits of Ararat and North knob at the same horizon.

I have identified the *Mount Pleasant conglomerate* here not without some misgivings, but still there are more reasons for than against it, because if this be not the *Mt. Pleasant conglomerate* then No. 1 must be that stratum; but the latter has the same elevation here as the conglomerate at Mt. Pleasant, 7 miles due north, and in that distance there ought to be a rise of 300′ in the rocks which would just bring No. 9 (1700′) up to the elvation (2000′) of the Mt. Pleasant stratum.

Then another point in favor of its identity with the *Mt. Pleasant conglomerate* is the fact that it contains a stratum near its base filled with reddish-colored quartz pebbles, a feature often seen in the former rock; it does not appear quite so massive here as usual; but its complete exposure to atmospheric influences in the vertical cliff has doubtless contributed somewhat to break it up, and render it less massive looking.

As we go still further east from this point, the rocks continue to rise quite rapidly in that direction for about one mile, when the dip begins to flatten very fast, and then the rocks soon become almost horrizontal.

About one and a half miles east from Griswold's Gap, a massive grayish-white sandstone, with a few pebbles, is seen at 1435′, still dipping northwestward, and this is most probably the representative of the *Cherry Ridge conglomerate.*

From the summit of Griswold's Gap a small stream starts westward toward the Lackawanna river, and this I descended on foot in hopes of getting some exposures of the *Sub-conglomerate measures;* but everything was concealed under piles of débris until the *Pottsville Conglomerate* came down; but then the stream descended along the dip of its layers, never cutting through; so that, with the exception of some beautiful exposures of the conglomerate in long inclined planes dipping 10° to 12°, nothing of interest is to be seen from the head of the stream to its mouth near Forest City. The western slope of the Moosic Mountains is thus formed by the *Pottsville, No. XII;* but at no locality in Clinton are any *valuable beds of coal* known to exist, though it is possible that in the wilderness skirting the left bank of the Lackawanna at the extreme western line of this township small patches of the coal mined at Forest City in Susquehanna county may exist.

Mr. Goodrich, the historian of Wayne, and an old surveyor, informs me that he once saw a *bed of coal* two to three feet thick along the Griswold's Gap stream, many years ago. It must have been one of the sporadic *Intra Conglomerate beds* however, and hence of no economic importance.

Near the eastern line of Clinton, at the cross roads near Mr. E. K. Curtis's, the following section is seen, descending to the left bank of West Lackawaxen creek: (Fig. 49.)

Curtis's section.

1.	Sandstone, massive, white, (*Honesdale Upper,*) base 1335′,	25′
2.	—— Concealed,	70′
3.	Sandstone, reddish,	15′
4.	—— Concealed,	75′
5.	Sandstone, reddsih,	15′
6.	—— Concealed to level of Lackawaxen,	40′
		240′

The *Honesdale Upper sandstone* contains a few pebbles; the rock weathers whitish, but on fresh fracture is seen to possess a grayish brown color.

The *Honesdale Lower sandstone* is concealed in the next lower interval.

Barometric elevations in Clinton.

	A. T.
Summit of Griswold's Gap,	1975′
Forks near E. Varcoe's,	1545′
" W. S. Harrison's,	1470′
" J. G. Dann's,	1465′
" M. Owl's,	1405′
Level of White Oak pond,	1375′
Forks at Baptist church in Aldenville,	1240′
Road at watering trough "	1230′
Forks near G. Gaylord's,	1320′
" A. Conyone's hotel,	1270′
" G. H. Tennant's,	1315′
Level of Lackawaxen just above,	1300′
Forks near F. Griner's,	1195′
Level of Lackawaxen just below,	1180′
Forks near H. Reynold's,	1165′
" T. Olver's,	1150′
Cross roads at E. K. Curtis's,	1140′
Level of Lackawaxen just opposite,	1120′

36. Dyeberry, in Wayne county.

This lies directly west from Clinton, has Mt. Pleasant and Lebanon townships on its northern border, and Texas on its southern.

The drainage is southward into Lackawanna creek, principally by way of Dyeberry creek, and other tributaries. The Dyeberry flows in a Drift filled valley, heaps and hummocks of morainic material being seen as far north as Tanner's Falls, and extending from thence southward all along its course; it thus becomes a very sluggish stream, and the evidence would point to a very deeply buried valley, especially in the lower portion of its course, since at no locality below Tanners' Falls do we see any rock bottom.

The rocks in Dyeberry belong entirely to the *Catskill system*, the highest ones noted being the *Cherry Ridge group*, while the lowest exposed strata come 300′ to 400′ below.

The HONESDALE SANDSTONE GROUP is exposed in an almost constant line of grayish-white cliffs along the banks of this stream from its northern line to its southern.

At Tanner's Falls, its base comes in the hills at 1300′ A. T. At 150′ lower, we see a very massive, greenish-gray stratum, over which Dyeberry makes a plunge of about 25′ at the Falls, thus affording very fine water-power for the immense tannery located there.

Glass sand.—Two miles northwest from Bethany, the old county seat, there are two small lakelets which are generally known by the names of Glass Factory Ponds, since in former times a glass manufactory obtained its sand around their shores. The origin of these beds of loose sand, fit for glass making purposes has been quite a mystery to many, but the matter is easily solved when one observes closely the character of the surroundings; for, extending all around the lower pond is a low cliff of grayish-white sandstone, partially submerged. The gradual decay of this stratum through swash of the waves and other atmospheric influences has furnished the sand grains; the wear and tear of the grinding has pulverized the finer material, and at the same time thrown up the sands in heaps where we now find them. It is possible that the grinding action of the northern ice filling these ponds may have contributed something toward the pulverization of the sandstone, but that its origin came about from the action of some forces on this local rock cannot be doubted. The stratum which skirts the pond at an elevation of 1475′ above tide, is the *Cherry Ridge conglomerate* or at least one of the sandy deposits of that group.

These ponds are supplied by springs and the city of Honesdale now receives its water from them through the new works that have recently been erected.

Barometric elevations in Dyeberry.

	A. T.
Forks at Tanner's Falls,	1140′
Level of Dyeberry near J. D. Bolkeau's,	1070′
Forks near School House No. 4,	1070′
Level of Dyeberry there,	1060′
“ at E. B. Kimble's,	1030′
Forks at School House No. 2,	1030′
Forks near H. J. Boreher's,	1340′
“ F. Smith's,	1350′
Level of Dyeberry at Wayne County fair grounds,	995′
Forks near J. B. Ward's,	1280′

Level of creek next north,	1265′
Forks near J. Darry's,	1270′
Wayne St., Bethany, at Isaiah Scudder's,	1400′
" " corner of Sugar St.,	1425′
" " " Court St.,	1440′
" " " Beech St.,	1500′
Forks near William Stephen's,	1525′
" H. H. Webb's,	1480′
" J. Brown's,	1440′
" C. Faatz 's,	1370′
Level of Glass Factory Pond,	1460′
Forks of road near William E. Pethick's,	1555′
Level of stream at W. A. Oliver's,	1380′

37. *Oregon, in Wayne county.*

This lies directly east from Dyeberry, has Lebanon at the north, Berlin at the south, and Damascus on the east.

The drainage from all except the extreme eastern portion is into Lackawaxen creek by way of Carly, Big Brook and other streams.

The rocks of the township belong exclusively to the *Catskill system*, and to that portion of it immediately below the *Cherry Ridge conglomerate*, since this latter stratum is found only on the tops of the highest summits.

Several ponds or small lakelets are scattered over its surface as monuments of the former *glaciation* to which it has been subjected; among these are Upper and Lower Wilcox, Day, Spruce, Mud and Lovelace. These are all surrounded by banks of Drift, left by the retreating glacier.

A long high ridge runs north and south through the central portion of the township, and this is capped with the *Cherry Ridge conglomerate*, which is often seen in lines of cliffs, and also huge *bowlders* scattered over the surface.

At school-house No. 4, in the eastern portion of the township, a grayish-white ledge of sandstone extends around the hills; base 1500′ A. T. The stratum continues up to 1535′ and most probably represents one of the *Cherry Ridge series*, since it comes too high for the *Honesdale group* unless there should be a sudden and rapid eastward rise between this point and Honesdale.

About 2 miles west from the former locality, and near Wefferling's Tannery, a massive grayish-white stratum of sandstone is seen at 1475′, and below it comes a layer of *calcareous breccia* which very probably represents the *Cherry Ridge limestone.*

As we pass eastward from the Upper Wilcox Pond, the base of a gray sandstone is seen at 1450′ A. T. and 60′ higher up is seen the base of a grayish-white rock with a layer of *calcareous breccia* at its base.

Barometric elevations in Oregon.

	A. T.
Forks near M. E. church at south line of township, . . .	1400′
" A. Fox's, ...	1520′
Cross roads at School House No. 4, ...	1490′
Forks near D. Agin's, ...	1480′
Cross roads near S. Knapp's, ...	1485′
Forks near E. Corbin's, ...	1290′
Level of Carly brook near J. Riefler's, ...	1200′
Forks south of T. Galvin's, ...	1235′
Forks next south, one half mile, ...	1270′

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38. *Berlin, in Wayne county.*

This township lies southeast from Oregon, having it and Damascus for its northern boundary, Pike county on its southeast line, while its extreme eastern point rests on the Delaware river opposite the village of Narrowsburg, N. Y.

The drainage of the district is quite complicated, the water form the western portion going into the Lackawaxen; that from the central and southeastern portions passing off through Pike county into the Delaware; while that from the northeastern corner goes eastward to the river through Corkin's creek.

The rocks of the township belong exclusively to the *Catskill system*, the top of the *Chemung* being buried under several hundred feet of overlying red and gray rocks even at the deepest water-way on the Delaware river.

The massive *Catskill cliff sandstones* crop out in bold bluffs at many localities within the township.

The *Honesdale Lower sandstone* is seen standing out in along cliff outcrop just west from Berlin Center; its base 1235′ A. T.

At the south-western line of Berlin the following section is seen descending along the road which leads to Indian Orchard: (Fig. 50.)

Indian Orchard road section.

1. ***Red shale***, (Cherry Ridge,)	50′
2. Sandstone, grayish white, (*Honesdale Upper*,)	30′
3. ——Concealed,	130′
4. Red shale, (Montrose, lower part,)	30′
5. Greenish-gray sandstone, (top 1025′ A. T.,)	25′
	265′

No. 1 is the presistent *red* horizon found below the *Cherry Ridge limestone*, since No. 2 is the *Honesdale Upper sandstone.*

The *Montrose red shales* are partly shown in No. 4, and doubtless more of the same material exists in the concealed interval above.

The lowest member of the section is very probably the one which has been quarried in the hill opposite Honesdale, and which I have elsewhere termed the *Paupack sandstone.*

The *Honesdale Upper sandstone* is also seen just east from school-house No. 4; top 1325′ A. T.; and above it *red shales* appear.

In going eastward from this last locality the strata appear to have a slight dip, since when we come to Mr. J. William's, 2 miles away, the base of the *Honesdale Lower sandstone* is seen at 1240′ A. T.

Near R. Gregory's, two miles further east, we see the outcrop of two cliff sandstones, separated by 25′ of shales; base of upper 1185′ A. T. This may represent the *Honesdale Lower sandstone.*

As we go towards the southern line of Berlin the rocks appear to thicken up and become much coarser, many of the beds having become pebbly.

One of these makes a great line of cliffs at 1155′ A. T., being 30′ thick, grayish-white in color, and very coarse; *red* *shale* comes immediately above. Still further west near A. Kitner's we find the *Honesdale Upper sandstone* 1300′ A. T.

In the vicinity of Beech pond, some ferruginous springs have led to the popular belief that valuable *iron ore* beds exist in that vicinity, but so far as is yet known, they merely indicate the presence of *Catskill red shales*.

Barometric elevations in Berlin.

	A. T.
Forks near J. Gallagher's,	1085′
" W. Beemer's,	1105′
Forks next south,	1270′
Forks at School House No. 2,	1255′
Forks near J. Young's,	1260′
" School House No. 3,	1365′
" D. Olver's,	1365′
Forks in Beech Pond P. O.,	1330′
Level of Beech pond,	1320′
Forks near T. B. Olver's,	1380′
" School House No. 5,	1485′
" C. Jay's,	1500′
" C. Spry's,	1385′
" A. B. Kellam's,	1030′
" H. S. Bishop's,	1210′
Level of Williams's pond,	1285′
Cross roads near J. Williams's,	1275′
Forks next east,	1230′
Crossing of stream next east,	1120′
Cross roads east from R. Gregory's,	1220′
Crossing of stream south of G. Shiner's,	1130′
Forks near School House No. 7,	1330′
Forks south from J. Garratt's,	1310′

39. Texas, in Wayne county.

This is a long narrow area lying west from Berlin, enclosing Honesdale, the county seat. Lackawaxen creek flows through its center from north to south, and drains its rainfall into the Delaware.

The valleys of the streams are filled with great deposits of *Drift*, which entirely conceal the bed-rock, and may possibly extend to a considerable depth below water level, since no explorations have ever reached its bottom.

The material of these Drift heaps consist largely of detri-

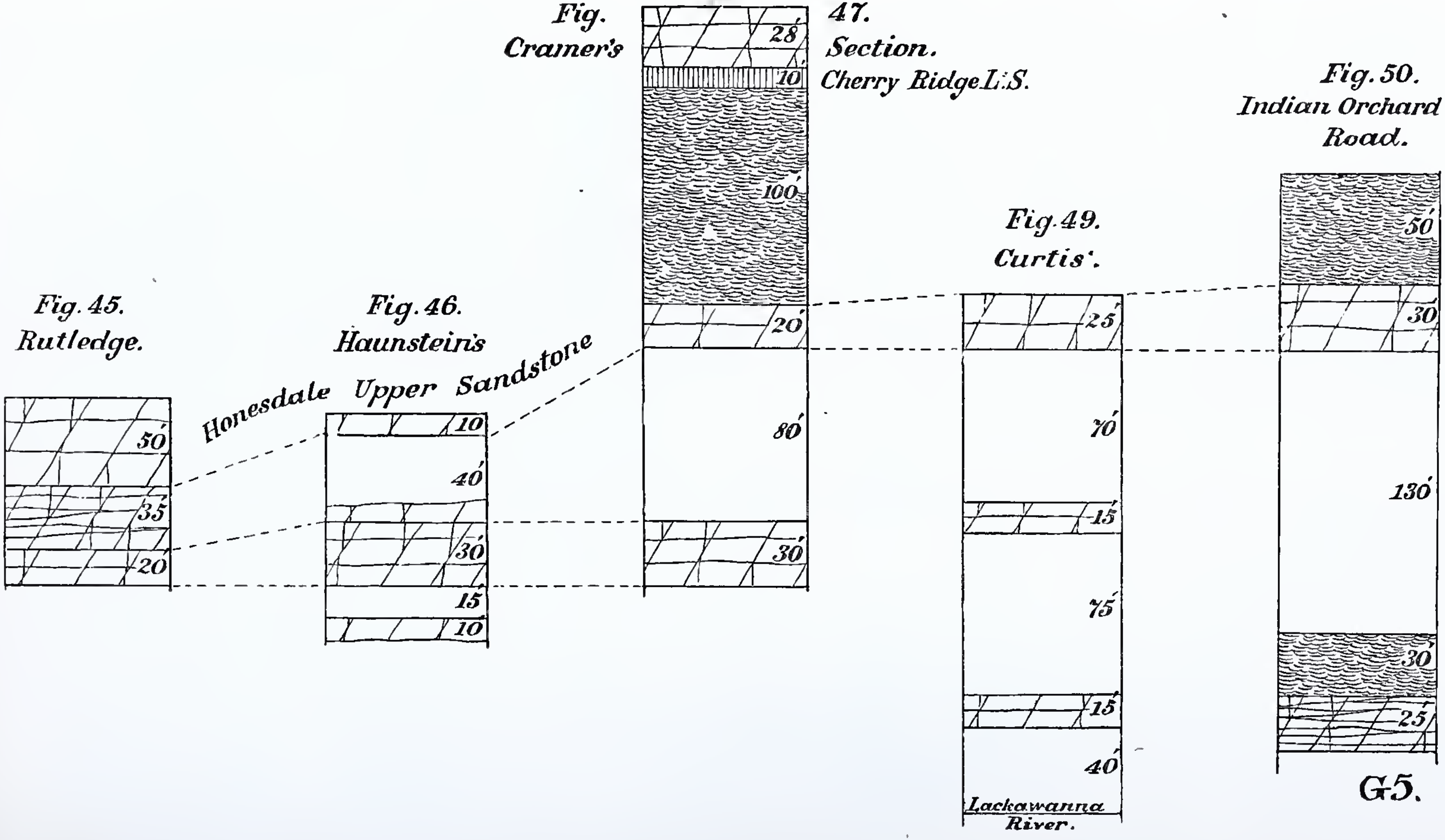


Fig. 45. Rutledge.

Fig. 46. Haunstein's

Fig. 47. Cramer's Section. Cherry Ridge L:S.

Fig. 49. Curtis'.

Fig. 50. Indian Orchard Road.

tal stuff with included *bowlders of local rock* varying in size from small pebbles up to fragments 5′ in diameter. No bowlders of *metamorphic rock* have been seen anywhere along the Lackawaxen valley.

The rocks of the township belong exclusively to the *Catskill series*, and are finely displayed along the bluffs, and steep slopes of the Lackawaxen.

On the east bank of Lackawaxen, opposite Honesdale the hill rises almost perpendicularly to a height of 300′, and is capped at top by a long bold cliff of massive sand rock, descending from which the following succession appears: (Fig. 51.)

Honesdale section.

1.	Shale, red, sandy,	15′
2.	Sandstone, massive, *Honesdale Lower*, (top 1275′ A. T.,)	50′
3.	Soft *red shale*,	3′ to 5′
4.	Sandstone, gray,	20′
5.	*Red shale* with some gray sandstone,	70′
6.	Grayish-green sandstone,	20′
7.	*Red shale*,	60
8.	*Paupack sandstone*,	35′
9.	—— Concealed to level of Lackawaxen creek,	35′
		310′

No. 2 is locally known as Irwin's cliff; on account of its commanding view and romantic features, it is much visited as a pleasure retreat. This is the lowest member of a tripple series which I have termed the *Honesdale Sandstone group*, consisting of massive sandstones at top and bottom with 40′ to 50′ of *red sandy shale* or *red sandstone* between, the bottom of which is seen in No. 1. The *Upper sandstone* has been eroded from the hill at this locality but is found in a higher knob further east.

The 175′ of measures between the *Honesdale Lower SS.*, and *Paupack SS.* come according to my identifications, at the same geological horizon as the great bed of *red shale* seen in the borough of Montrose, and which I have named *Montrose red shale.* The only difference is that in coming south-eastward some sandstone layers are interpolated where none are found at Montrose, in accordance with the general law that all the deposits grow coarser toward the southeast.

The *Paupack sandstone* has been quarried to a considerable extent along the bluff immediately above the creek road; a greenish gray rock which when seen in a building from a distance, much resembles serpentine. The Protestant Episcopal, and Catholic churches in Honesdale were largely constructed of this rock. Near the top of the stratum is a layer of *calcareous breccia*, which is quite irregular, often disappearing entirely, while throughout the rock, and especially between the layers are numerous fragments of *fossil plants*. On one slab in the possession of Prof. Dolph, I saw *Archæopteris* (*Cyclopteris*) *Jacksoni*, but this is the only determinable form that has ever been found there to my knowledge.

In the *red shale* immediately below the *Honesdale L. S.* a few nodules of *copper glance* were found several years ago, and in the temporary excitement an effort was made to open a copper mine which was of course, a failure. This 3′ band of blood red shale can be traced along the base of the cliff for more than a mile and is a conspicuous object from the valley of the Dyeberry.

About one and a half miles west from Honesdale, where the Light track of the Gravity R.R. makes the horseshoe curve the following section is seen in descending from the summit: (Fig. 52.)

Gravity R.R. section.

1.	—— Concealed, (top A. T. 1440′,)	35′
2.	Sandstone,	15′
3.	—— Concealed,	30′
4.	Sandstone, massive,	25′
5.	Red rocks,	30′
6.	Massive sandstone, (Honesdale Upper,)	20′
7.	Red shale and sandstone,	40′
8.	Massive sandstone, (Honesdale Lower,	25′
9.	Red shale,	10′
10.	Sandstone and red shales,	22′
11.	Sandstone, massive,	25′
12.	Red shale,	35′
13.	Sandstone, massive, (base 1105′ A. T.,)	20′
		332′

This section is only about two miles in an air line from where the preceding one was taken, and yet a considerable change in the character of the rock material is to be seen.

The *Honesdale Lower sandstone* is not so thick by half; while the *red shale* horizon below it seems to contain much more sandstone than at Honesdale. This is only one example of the sudden change in character and color which so often takes place in the *Catskill series* within very short distances.

The *Honesdale Upper sandstone* a grayish white stratum, quite massive, contains angular quartz pebbles the size of a pea.

Near the base of No. 10 a large bony plate of a *fossil fish* is seen imbedded in the rock.

In ascending the light track of the Gravity R.R. from Honesdale, a sandstone is seen at 1080′ A. T.; then at 1120 a *red shale* begins, and continues on up the hill to base of a massive sandstone near the engine house at 1170′.

The following section is seen opposite Tracyville, one mile below Honesdale, along the road leading to Bunnell's pond: (Fig. 53.)

Bunnell's Pond road section.

1.	Massive sandstone, (*Honesdale Upper*,)	20′
2.	—— Concealed,	75′
3.	*Red shale* (with very little concealed,) *Montrose*,	200′
4.	Sandstone, *Paupack*, visible, (top 1025′ A. T.,)	15′
		310′

There are one or two thin sandstones in the *200′ Montrose red shale*, one at 1100′, and another at 1065′ A. T.; below which last we see 40′ of blood red shale finely exposed along the little stream which descends to the creek at Traceyville.

The *Honesdale Lower sandstone* is most probably concealed in the 75′ interval just above the *Montrose red shale*.

On the opposite (west) side of the Lackawaxen valley the following structure is exhibited along the road which descends the hill below the Erie R.R. depot: (Fig. 54.)

Erie R.R. Depot section.

1.	Sandstone, grayish-white, (*Honesdale Upper*,)	25′
2.	—— Concealed,	50′
3.	Sandstone, (*Honesdale Lower*,)	25′
4.	—— Concealed,	110′
5.	Sandstone,	20′
6.	—— Concealed to Erie depot (966′ A. T.,)	135′
		365′

The *Honesdale Upper sandstone* is here seen in a long white cliff circling around the summit of the hill ; quite coarse, and containing some pebbles.

The tripple structure of the *Honesdale group*, seen at the top of this section, is characteristic over a wide area, the concealed middle portion usually consisting of *red shale* or *sandstone.*

About one half mile south from the locality where the *Honesdale Upper sandstone* of the preceding section occurs, we see it again in a massive cliff, its base 10′ lower, or 1305′ A. T., while above it at 1335′ a reddish-brown sandstone appears, and at 1365′ another, very massive, and grayish-white in color.

The *Cherry Ridge limestone* is seen cropping out in a long black band 4′ thick, along the road which leads out from Honesdale past Cadjaw pond, and it has an elevation of 1445′ A. T.

Barometric elevations in Texas.

	A. T.
Forks in Seelyville,	1065′
" Prompton,	1095′
Level of Bunnell's pond,	1100′
Forks near H. Bunnell's,	1095′
" Mrs. I. Sear's,	1125′
" J. Burn's,	1340′
" J. Koof's,	1250′
" D. Holbert's,	965′
" School House No. 10,	995′
" C. Dorflinger's,	1245′

40. *Canaan, in Wayne county.*

This township lies next west from Texas and extends to Lackawanna county for its western boundary.

The Moosic Mountain range passes through the extreme western portion of this area and all the surface east from it drains into Lackawaxen creek ; west from it however the drainage passes to the Susquehanna river by way of the Lackawanna.

The Honesdale Gravity R.R. passes across the Moosic range in this township through Rix's Gap at an elevation of 1900′ A. T.

The outcropping rocks belong principally to the *Catskill*, but along the western line, a narrow band of *Pocono* strata skirts the east face of the Moosic range, while only one half mile west from the township line the rapid westward dip brings down the *Pottsville Conglomerate No. XII* into the tops of the most elevated points.

Dip.—In this area we see the dying away eastward of the strong N. W. dip of the measures east from the Lackawanna coal basin. Passing east from Carbondale along the Gravity R.R. we see the strata rising southeastward at about 8° until the summit of Moosic is reached just within the edge of Canaan, when the rate gradually slackens to about 5° which is continued on beyond Waymart and then it still further declines until a short distance beyond the eastern line of the township the strata have become almost horizontal.

The following section was compiled in passing from the outcrop of the Conglomerate No. XII ½ mile west from the township line eastward across the Moosic range to Waymart: (Fig. 55.)

Waymart section.

1.	*Conglomerate*, white base of XII,	25′
2.	*Coaly shale*,	2′
3.	Sandstone, coarse, bluish gray,	15′
4.	Sandstone buff and sandy shales,	75′
5.	—— Concealed,	30′
6.	Sandstone, grayish white, few pebbles,	25′
7.	—— Concealed,	350′
8.	Sandstone, massive, gray,	25′
9.	—— Concealed,	150′
10.	Sandstone, grayish white,	25′
11.	—— Concealed,	100′
12.	*Pebbly sandstone, Griswold's Gap Conglomerate,*	40′
13.	—— Concealed,	250′
14.	Sandstone, massive,	20′
15.	Red shales, sandstones, and concealed,	300′
16.	Sandstone, reddish,	15′
17.	—— Concealed,	175′
18.	Sandstone, grayish brown,	40′
		1662′

This section must be considered as only approximately correct, since Nos. 7 and 13 were mere estimates from the

Honesdale Sections

Fig. 51.
Honesdale.

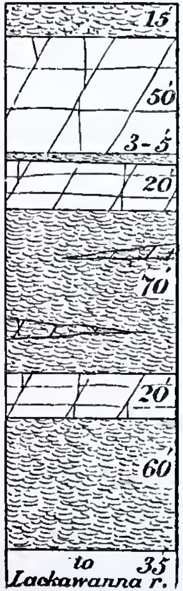


Fig 52.
Gravity R.R. Section.

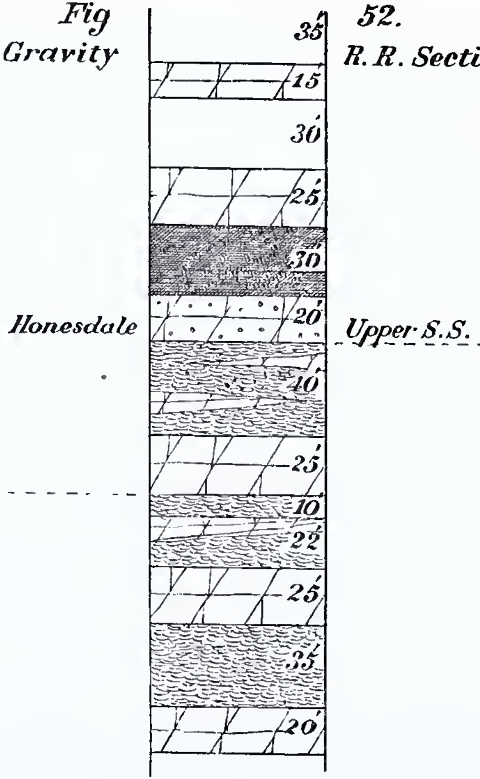


Fig 53.
Bunnell's Pond road.

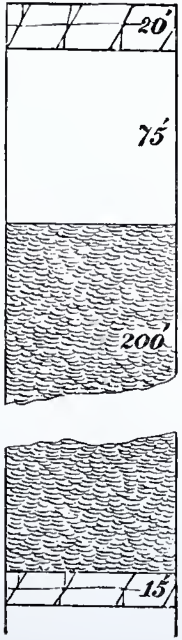
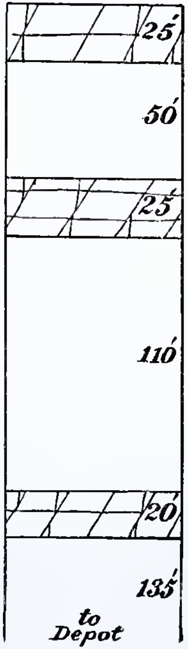


Fig. 54.
Erie R.R. Depot



observed rate of dip. But as the horizontal distance is more than a mile in the first case and about ½ mile in the second, there is plenty of room for change in rate of dip, and hence for a considerable error. However I do not think these estimated intervals can be more than 100 out of the way for both, and possibly much less.

Pottsville conglomerate.—The base of No. XII occurs just across the Wayne county line, in the edge of Lackawanna, where it caps a high ridge in a bold cliff of snow white rock, a perfect agglomeration of small quartz pebbles, there being apparently very little fine sand in its composition; on account of its purity, and freedom from iron it has been largely quarried and used in the *manufacture of glass* at Honesdale and other places. The dip is here 8° N. 35° W. magnetic. From this point the rock descends westward at the same rate as the slope of the Moosic range, and passes under water level beneath the Lackawanna river not to reappear until we cross the *coal basin* and find it coming up to daylight again in the Lackawannock range.

The dip due west from the high ridge is 4°, as I determined by obtaining a sight on the outcrop of the rock one-half mile down the mountain.

The *coaly shale* and two succeeding members of the series were seen along the stream which descends to Honesdale from No. 4 Pond.

The *Griswold's Gap conglomerate*, is quite massive, and huge *blocks* of it are strewn over the surface around its outcrop, which comes about one half mile east from the summit of the Moosic range; the rock contains immense quantities of large angular, very white quartz pebbles, imbedded in a matrix of coarse darkish gray sand which weathers whitish on exposure; near the base of the stratum is a layer of *calcareous conglomerate* (2′ to 3′) containing many *fish bones*, *quartz pebbles*, *pieces of red and greenish shale*, together with *rounded chips of sandstone*.

The sandstones both above and below this stratum are quite massive though few of them contain any pebbles, and most of them are much current-bedded.

The lowest member of the section has been quarried to a

Weymart Section.

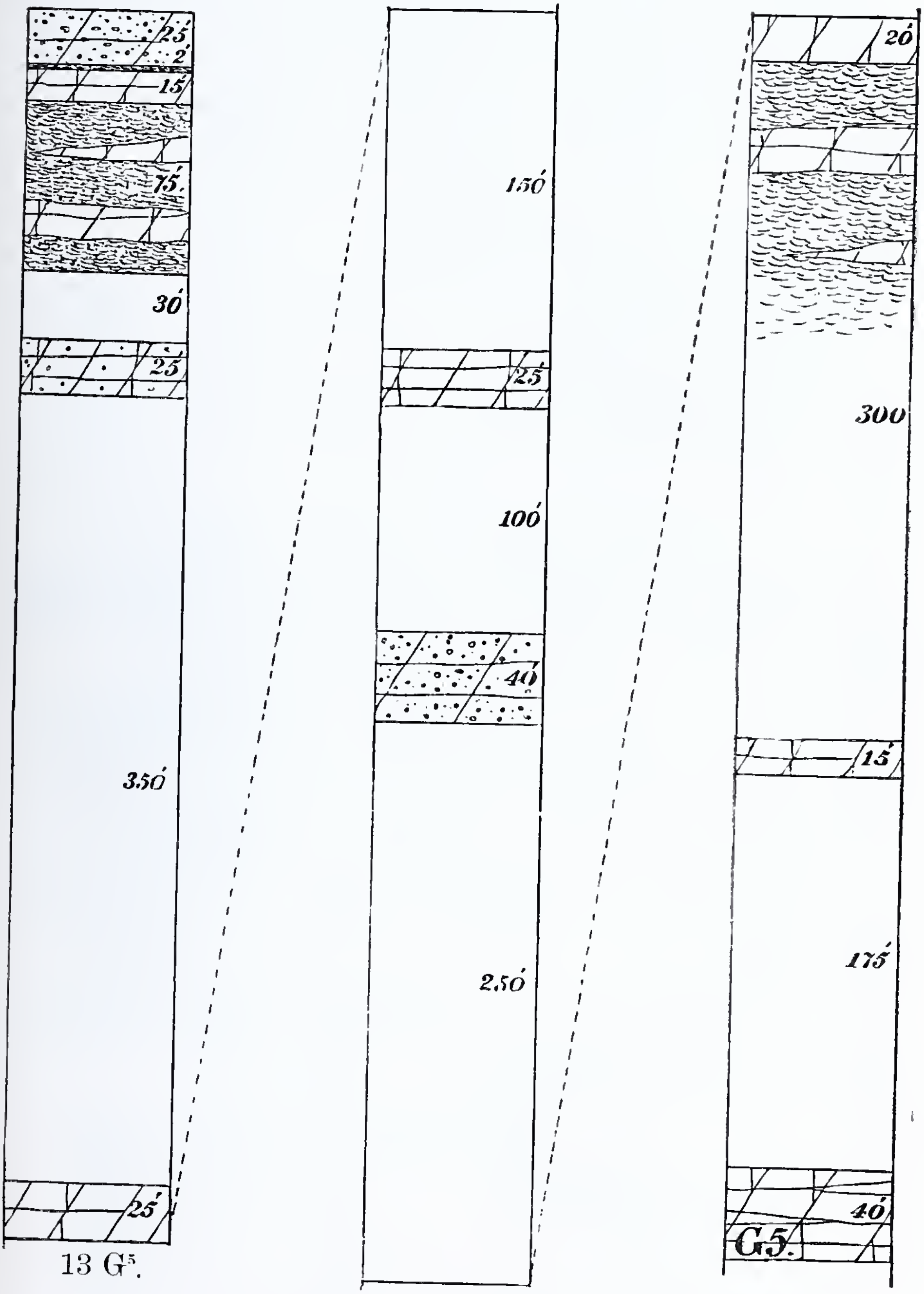


Fig. 55 a. Fig. 55 b. Fig. 55 c.

considerable extent, just north of Waymart, and some very nice *flagging* obtained ; it comes just above the horizon of the *Cherry Ridge conglomerate.*

East from Waymart, on the south shore of Keen's Pond, a grayish white cliff is seen skirting the same at 1340′ A. T.; it is most probably the *Cherry Ridge conglomerate*, unless it be the *Honesdale Upper sandstone*, for which however the elevation would be too great.

Barometric elevations in Canaan.

	A. T.
Summit in Rix's gap on Carbondale pike,	1975′
Forks near G. Chase's,	1930′
Level of Keen's pond,	1320′
Forks near E. C. Keen's,	1340′
Cross roads near J. D. Keen's,	1330′
" J. McCarty's,	1420′
Forks near P. Ryan's,	1420′

41. South Canaan, in Wayne county.

This lies immediately south from Canaan and like it joins the Lackawanna county line, being drained entirely by the Middle Branch of Lackawaxen and its tributaries.

The Moosic mountain range passes along the western line of this township, getting further and further away toward its southern part, since this range now takes a southwestern direction parallel to the Lackawanna Coal Basin.

The rocks of the township belong to the *Catskill series* except a very narrow belt at the extreme northwestern corner, where the lowest members of the *Pocono* cap the highest summits.

On the road that crosses the Moosic mountain, next south from Rix's Gap, the following succession is seen just west from the Wayne county line.

Crest section.

1. Summit covered with blocks of *Vespertine Cong.* at 2240′ A. T.	
2. Sandstone, massive, gray,	30′
3. —— Concealed,	125′
4. Sandstone, gray,	20′
5. —— Concealed,	85′
6. Sandstone, pebbly, grayish white, (base 1840′ A. T.,)	25′

The summit of Moosic is here covered with large *blocks* of a grayish white pebbly rock, which doubtless belong to the *Griswold's Gap conglomerate horizon*; they are not in place however, and hence may belong 50′ to 100′ higher. Should this uppermost member of the section represent the *Griswold's Gap conglomerate* then would the lowest member be identical with the *Mt. Pleasant conglomerate.*

In many portions of this township a grayish-white pebbly sandstone is seen making great lines of cliffs along the hills at about 1400′ A. T.; it is far too low for the *Mt. Pleasant conglomerate*, and hence must be the *Cherry Ridge conglomerate*, since this is often quite pebbly in the southern townships of Wayne.

One of these localities is in the eastern portion of the township just south from Mr. J. Hesley's, where a bold outcrop of grayish-white pebbly sandstone extends for a long distance, dipping N. W. about 30′ per mile; base 1390′ A. T.

A short distance east from Larix P. O. a massive gray pebbly sandstone is seen at 1355′ A. T. and this is most probably the same *Cherry Ridge conglomerate.*

Barometric elevations in South Canaan.

	A. T.
Cross roads near N. Chumard's,	1450′
Level of creek next southwest,	1175′
Forks near W. Chumard's,	1275′
" M. Cary's,	1265′
Level of run west of L. Reed's,	1185′
" next west,	1175′
Cross roads near M. Curtis's,	1215′
Forks near M. Shaffer's,	1300′
Level of creek crossing next northwest,	1250′
Cross roads in South Canaan P. O.,	1400
Level of creek just west,	1300′
Level of stream near L. Branson's,	1325′
Forks near D. Branson's,	1410′
" H. Newton's,	1385′
Level of stream west of E. Spangenbergh's,	1465′
Forks next west (in Lackawanna county,)	1560′
Cross roads near S. Ensling's,	1475′
Forks near S. Swingle's,	1390′
Level of stream next east,	1335′
Forks near School House No. 8,	1415′
Level of stream next east,	1285′
Forks near Curtis's pond,	1360′

Cross roads at School House No. 7,	1465′
Level of stream at Cole's mill,	1255′

42. *Cherry Ridge, in Wayne county.*

This township lies directly east from South Canann, and is drained by the Middle Branch of Lackawaxen.

Its rocks belong entirely to the *Catskill*, and the highest stratum occurring in any of its summits comes about 300′ above the base of the *Honesdale Lower sandstone.*

It is from the village of Cherry Ridge in this area that I have designated a group of rocks which have a remarkable horizontal extent all over Wayne county, and even into Susquehanna.

Just west from Cherry Ridge P. O. on the land of Mr. Collins the following is seen in descending from the summit of the hill: (Fig. 56.)

Cherry Ridge section.

1. Pebbly sandstone, *Cherry Ridge conglomerate*,	25′
2. —— Concealed,	30′
3. Sandstone,	20′
4. *Limestone*, impure, brecciated, *Cherry Ridge*, (base 1425′ A. T.,)	5′
5. *Red shale* and concealed to level of stream,	100′
	200′

This whole series I have termed the *Cherry Ridge group*, there being a *conglomerate*, a *sandstone*, a *limestone*, and a *red shale*, each of which I have proved to be quite persistent.

The *Cherry Ridge conglomerate* is darkish-gray, full of angular quartz pebbles, and occasionally contains a layer of *calcareous breccia*, quite similar to the persistent band below; it looses its pebbly character on going north from the central line of Wayne, however, and is then merely a coarse sandstone.

The *Cherry Ridge sandstone* and *limestone* under it, properly make up but one stratum since they are invariably found in immediate contact, each varying in thickness at the expense of the other. The sandstone portion is grayish-white, and at this locality contains a few pebbles. In the crevices of this stratum we also find great numbers of quartz crystals attached to the faces of the stone ; some are two inches long by one quarter inch thick. Their presence here where the strata are almost horizontal is somewhat remarkable, since they must have originated by crystalization from some solution at very little above the ordinary temperature.

The *Cherry Ridge limestone*, which is so very persistent over Wayne and Susquehanna counties, comes just at the base of the *sandstone* and contains a few pebbles of quartz in addition to the *fish bones*, *pieces of shale* and other foreign matter which it usually holds. A short distance south from Mr. Collins's, the limestone has been burned for agricultural purposes by Mr. J. R. Schenk ; the rock is very hard and breaks with great difficulty ; only about half of that placed in the kiln slacks down on exposure, the rest coming out in sandy porous nodules, while some portions even melt down into a slag.

Specimens of the rock richest in lime and that much poorer looking were sent to McCreath who returned the following analyses :

	I.	II.
Carbonate of lime,	64.392	19.785
" " manganese,	1.816	3.518
Oxide of iron and alumina,	4.145	8.903
Phosphorus,	.050	.095
Silicious matter,	28.800	65.470

These analyses show that the best of the rocks may be burned successfully for agricultural purposes in a country like Wayne county where it is the only obtainable lime-rock and where the land is famishing for lime. (See p. 65, above.

The poorer qualities of the stone like No. II specimen can not be successfully burned however as they will either not "slack" or else fuse into a glassy slag and hence some discrimination is necessary in selecting the stone for burning.

On the road between Clark's Corners and Honesdale, the *Cherry Ridge limestone* is seen cropping out along the hill side in a band of massive black looking blocks 5′ to 6′ thick and 8′ to 10′ long; elevation 1450′ A. T. It is also seen near Cadjaw pond at the same elevation.

Barometric elevations in Cherry Ridge.

	A. T.
Level of Cadjaw pond,	1295′
Forks near J. Baker's,	1315′
" J. Rose's,	1345′
Level of stream next west,	1285′
Cross roads near T. Jordan's,	1385′
Forks near H. L. Phillip's,	1310′
Cross roads next west,	1275′
Forks near J. Brady's,	1350′
" J. Buekley's,	1355′
Level of stream near P. Clark's,	1390′
" A. Curtis's,	1265′
Level of Sand pond,	1350′
" Penna. Gravity R.R. near G. C. Brown's,	1200′
" Collin's brook just east,	1115′
Forks near D. D. Woodward's,	1145′
" School House No. 6,	1185′
Forks next northeast,	1175′
" near I. Bonear's,	1130′
Clark's Corners,	1175′
Forks near School House No. 1,	1315′
" P. McGarry's,	1280′
" J. Lintner's,	1275′

43. *Palmyra, in Wayne county.*

This lies along both sides of the Lackawaxen creek, east from Cherry Ridge, and extends eastward to the Pike county line.

The rocks of the township belong to the *Catskill series*, and are finely exposed along the steep bluffs of the Lackawaxen and Wallenpaupack.

Following the general law of growing coarser toward the S. E., the rock of this area contain pebbles in some of the beds at the same horizons where none are seen to the north, there being generally more sandstone and less shale than we see in the series further north.

In the vicinity of White's Mills, a great many successive beds of greenish gray sandstones crop out in bold cliffs from. the bed of the Lackawaxen far up to the summits of the hills; and at 1240′ A. T., ¾ m. east from the village, we come to the base of a massive conglomerate very full of large angular yellowish white quartz pebbles. There is some doubt about the exact place which this stratum occupies, but the probabilities are in favor of its representing the *Honesdale Lower sandstone horizon*, since about 65′ above it we get up to another grayish white pebbly sandstone, at about the same elevation above tide with the *Honesdale Upper sandstone* one mile and a half northward in the southern edge of Berlin.

These two pebbly sandstones are seen at several localities along the ridge road running parallel with Lackawaxen creek and one mile east from it.

Wallenpaupack creek, or as it is generally called "Paupack," enters the Lackawaxen from the south just below Hawley, passing over the massive sandstones of the *Catskill* in a series of cascades known as Paupack Falls, thus exposing a beautiful section of the rocks.

From Wilsonville, at the head of the rapids, to the Lackawaxen at the mouth of Paupack, is only a little more than a mile, and yet in this distance the stream descends 250′, the greater part of which is in the lower half of its course.

In descending the Paupack from Wilsonville, the following section was obtained: (Fig. 57.)

Paupack Falls section.

1.	Sandstone, massive, (top 1125′ A. T.,)	10′
2.	*Shales* reddish, sandy,	20′
3.	Sandstone, pebbly, grayish white,	25′
4.	—— Concealed,	30′
5.	Sandstone, greenish gray, *Paupack*,	20′
6.	Sandstone, reddish, shaly,	35′
7.	Sandstone, massive, (top of first large cascade,)	10′
8.	Sandstone, shaly,	15′
9.	Shales, *red* and *variegated*,	20′
10.	Sandstone, massive, gray, (top of second cascade,)	50′
11.	Shales, dark,	15′
12.	Sandstone flaggy to foot of third cascade, (875′ A. T.,)	35′
		285′

The uppermost member of the section, together with the dam at Wilsonville, makes a cascade of 20′ at that locality, and then the stream descends in a series of rapids until the top of No. 7 is reached, when in three successive leaps, including the rapids between, it descends a vertical height of 145′ in a horizontal distance of about 100 yards. As the Paupack carries a considerable volume of water at all seasons of the year, this is the finest site for water power in the county. Strange enough it has hitherto been allowed to run to waste with the exception of a small modicum utilized by a tannery and flouring-mill. There is now, however, a large silk manufactory in process of construction, which takes its water power from the top of the first cascade, and thus gets the pressure of a column of water 50′ high on its turbine wheel. There is still plenty of room and power for other factories on each bank of the stream.

The only member of this section to which any especial attention need be called is the stratum which I have designated from this locality, the *Paupack sandstone*, a greenish gray, or sometimes bluish green rock, extensively quarried along the banks of Paupack one fourth mile above the first cascade. It comes in layers 4″ to 8″ thick and was used in building the silk factory at the "falls;" it very much resembles the quarry rock in the hill opposite Honesdale, and is doubtless the same stratum; elevation 1050′ A. T.; (25′ higher than the top of the Honesdale rock,) but this is in favor of their identity, since there is a slight rise in the rocks southward between Honesdale and Hawley. It makes a beautiful building and from a short distance very much resembles the Serpentine structures of Philadelphia.

A short distance below Wilsonville a great bed of Drift is seen at the roadside 1090′ A. T.

Barometric elevations in Palmyra.

	A. T.
Forks near Wm. Elson's,	1280′
" next west,	1245′
Level of Ridge pond,	1300′
Level of water in dam at Wilsonville,	1125′
" at foot of third cascade, (Paupack falls,)	875′

44. Paupack, in Wayne county.

This lies west from Palmyra, and is separated from Pike county on the south by Paupack creek. A great contrast exists between the Paupack creek of this township and the same stream along the border of Palmyra. There it descends in a regular cataract; here its fall is so gentle as to be scarcely perceptible; from Wilsonville where it leaves this township to the western line of the same, a distance of 10 miles by the stream, the fall is only 2′ per mile. A small *steamboat* used to run regularly between Wilsonville and the Ledgeville tannery 12 miles above.

The reason of this gentle flow is to be seen in the nature of the material through which the stream has been compelled to cut its channel; for a vast bed of *Drift* occupies all the valley, and the stream does not cut through it until we come to Wilsonville.

The rocks of the township belong entirely to the *Catskill series*, and the highest strata possibly extend up to the *Cherry Ridge group.*

Near the cross roads at L. Kimble's a greenish-gray pebbly sandstone lies at 1465′ A. T., and immediately below it a bed of dull *red shale;* these may possibly represent a portion of the *Cherry Ridge group*, the upper probably being the *Cherry Ridge conglomerate*, since about 40′ below it we see another coarse pebbly sandstone.

Where the road crosses the run near Mr. W. Ansley's the base of a massive grayish white sandstone is seen at 1375′ A. T.

Just west from Hemlock Hollow P. O. we see a very massive ledge of sandstone at 1375′ A. T. and on above this we come to the base of a grayish-white pebbly bed of sandstone at 1425′.

Near Station No. 15 on the Pennsylvania Coal Co.'s R.R. the outcrop of a massive sandstone occurs at 1225′ A. T. and at 1315′ a very pebbly stratum comes in with considerable *calcareous breccia* near its base.

Near the summit of the plane at Station 16, a massive, pebbly, grayish-white sandstone, 20′ thick, is seen at 1400′; 50′ above is another stratum somewhat thicker and more pebbly; these may possibly represent the *Cherry Ridge group*, the *calcareous* member having disappeared when the deposits became very coarse to the south.

Where the Pennsylvania Coal Co.'s *heavy track* passes across the Middle Branch of Lackawaxen, 4 miles from Hawley, the stream makes a vertical plunge of 20′ over one of the Catskill massive sandstones, which exhibits at this locality a very *curious structure*, in that the bedding plane of the sandstone appears to conform to the shape of the falls, curving over its top and down the sides like a sheet of water passing over the same; it seems to be the result of false bedding combined with a kind of concretionary structure in the rock.

Barometric elevations in Paupack.

	A. T.
Cross roads near Wm. Bray's,	1450′
Forks near R. R. Purdy's,	1405′
" H. H. Cole's,	1450′
Level of stream near W. Ansley's,	1350′
Forks south of S. Kimble's,	1400′

45. Salem, in Wayne county.

This lies directly west from Paupack, and has the West Branch of Wallenpaupack creek for its southern boundary, while its western is Lackawanna county.

The rocks of the township belong entirely to the *Catskill series.*

Near M. Holland's in its southwestern corner a massive pebbly sandstone is seen at 1400′ A. T. and its upper surface is grooved by *Glacial scratches;* S. 12° W. magnetic.

Descending from this to Ledgedale the following succession appears: (Fig. 58.)

Ledgedale section.

1. Sandstone, massive, pebbly, (top 1400′ A. T.,)	20′
2. —— Concealed,	25′
3. Sandstone,	15′
4. —— Concealed,	100′
5. Sandstone, gray, pebbly,	25′
6. —— Concealed, with some outcrops of massive sandstone,	110′
7. Sandstone, dark gray, pebbly to level of Paupack,	25′
	420′

This is the first locality where any sandstone occurs in the bed of the Paupack after leaving Wilsonville, 12 miles below; here all at once however the stream bed narrows up and cuts a vertical channel in the lowest member of the above section, about 200 yards long and only 20′ to 30′ wide; the pebbly sandstone cropping out in immense ledges on each side of the gorge have given name to the village.

Near Marsh Pond at 1445′ A. T. a pebbly white sandstone is seen which contains some *calcareous breccia.*

On the land of S. B. Dolph, just south from Jones's Lake the *Cherry Ridge sandstone* occurs at 1465′ A. T. and on above at 1490′ a massive pebbly sandstone is seen which also contains some *calcareous breccia.*

At the head of the plane, Station 17 of the Pennsylvania Coal Company the track is on the top of a very massive grayish-white pebbly sandstone 1440′ A. T., and 50′ below it another occurs very much like it, while at 1365′ a dark sandstone is seen.

Barometric elevations in Salem.

	A. T.
Forks near M. Holland's,	1475′
Level of creek near B. G. Morse's,	1155′
" Paupack at Ledgedale,	1150′
Forks near J. Uban's,	1150′
" J. W. Bidwell's,	1275′
Level of stream next north,	1300′
Forks near W. H. Wetherall's,	1335′
" A. Stocker's,	1395′
Level of Marsh pond,	1400′
Forks near J. Hogancamp's,	1450′
" H. H. Blois's,	1400′
" H. W. Polly's,	1440′
Level of Jones's pond,	1425′
Forks at Jonestown School House,	1485′
Cross roads near George Tisdel's,	1510′
Crossing of Penna. Coal Co.'s track next north,	1460′
Forks near G. Green's,	1385′

46. Sterling, in Wayne county.

This township lies directly south from Salem, from which it is separated by West Wallenpaupack, while the South Branch of the same separates it from Pike county on the east, and on the south lies Monroe. It is drained almost entirely by the tributaries of Wallenpaupack, but the extreme southern portion bordering on Monroe sends its rainfall southward into the Lehigh river system.

The rocks of the township belong to the *Catskill series* though along the western border, some very pebbly white rocks look very much like *Pocono* strata.

About one half of this area is a barren waste, being that of the southeastern portion; this is very elevated and mountainous, being 1800′—2000′ A. T.

At many localities in the township a great band of black *calcareous breccia* is seen at 1400′—1450′ A. T. and it most probably represents the *Cherry Ridge limestone.*

This stratum occurs at South Sterling P. O. In going westward to the North and South Turnpike we come up to a great bed of grayish white conglomerate at 1800′ A. T.; the pebbles are large and many of them reddish. This may possibly represent the *Mt. Pleasant conglomerate,* since it comes 350′ above the the *Cherry Ridge limestone.*

About one mile east from Nobleville the following succession is exposed in descending to Butternut creek.

Nobleville section.

1. Sandstone, with calcareous layer at base,	25′
2. —— Concealed,	30′
3. Sandstone, grayish white,	20′
4. —— Concealed,	15′
5. Sandstone, visible,	5′
6. Red *sandstone and shale,*	40′
7. Sandstone, grayish white, (base 1260′ A. T.,)	30′

It is quite possible that the lowest portion of the preceding series may represent the *Honesdale sandstone group,* since the place of the great black *calcareous breccia* is 50′ above the uppermost member of the section.

Just west from this last locality, *glacial striae* going S. 20° W. magnetic, occur on the surface of the massive gray sandstone at the roadside, 1475′ A. T.

One mile southeast from this, near the church at the cross roads, the outcrop of a thick band of *calcareous breccia* is

Fig. 56.

Cherry Ridge Section.

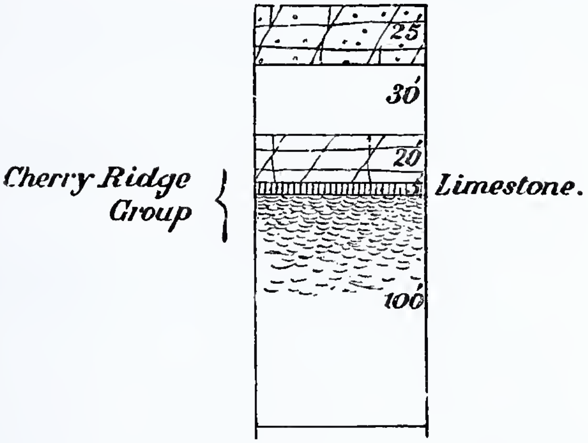


Fig. 57.

Paupack Falls.

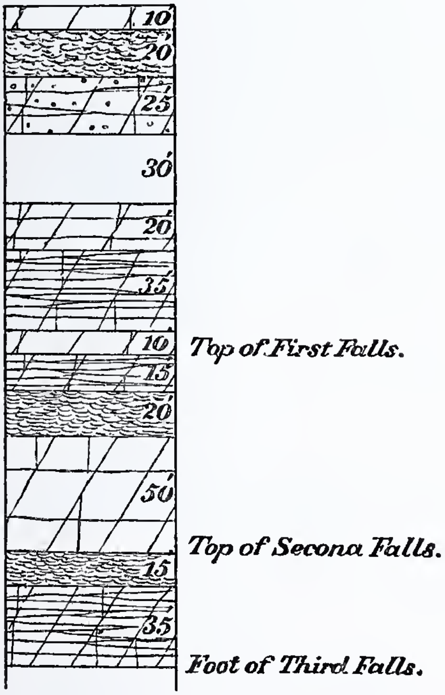
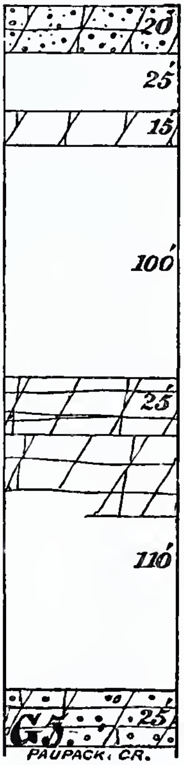


Fig. 58.

Ledgedale.



seen at 1455′ A. T. ; it is most probably the *Cherry Ridge limestone.*

Near East Sterling school-house, a grayish white sandstone occurs at 1350′ A. T., and in the hill above at 1460′ comes a *calcareous breccia* at the base of a dark massive sandstone.

At the northwestern corner of the county a white pebbly sandstone is seen at 1800′ A. T. ; it most probably represents the *Mt. Pleasant conglomerate.*

On west from this between the Wayne county line, and Moscow in Lackawanna county, we pass over the summit divide at 1800′, and see a white pebbly sandstone at 1875′ A. T.

Barometric elevations in Sterling.

	A. T.
Forks near Red School House,	1625′
“ W. J. Wallace's,	1635′
“ M. D. Caterson's,	1615
Level of stream next east,	1520′
Cross roads in Nobleville,	1620′
Forks near A. B. Williams's,	1360
Level of Butternut creek just south,	1350′
Forks of road near East Sterling School House,	1360′
Cross roads in New Foundland P. O.,	1335′
Forks at South Sterling,	1465′
“ south from H. Simpson's,	1950′

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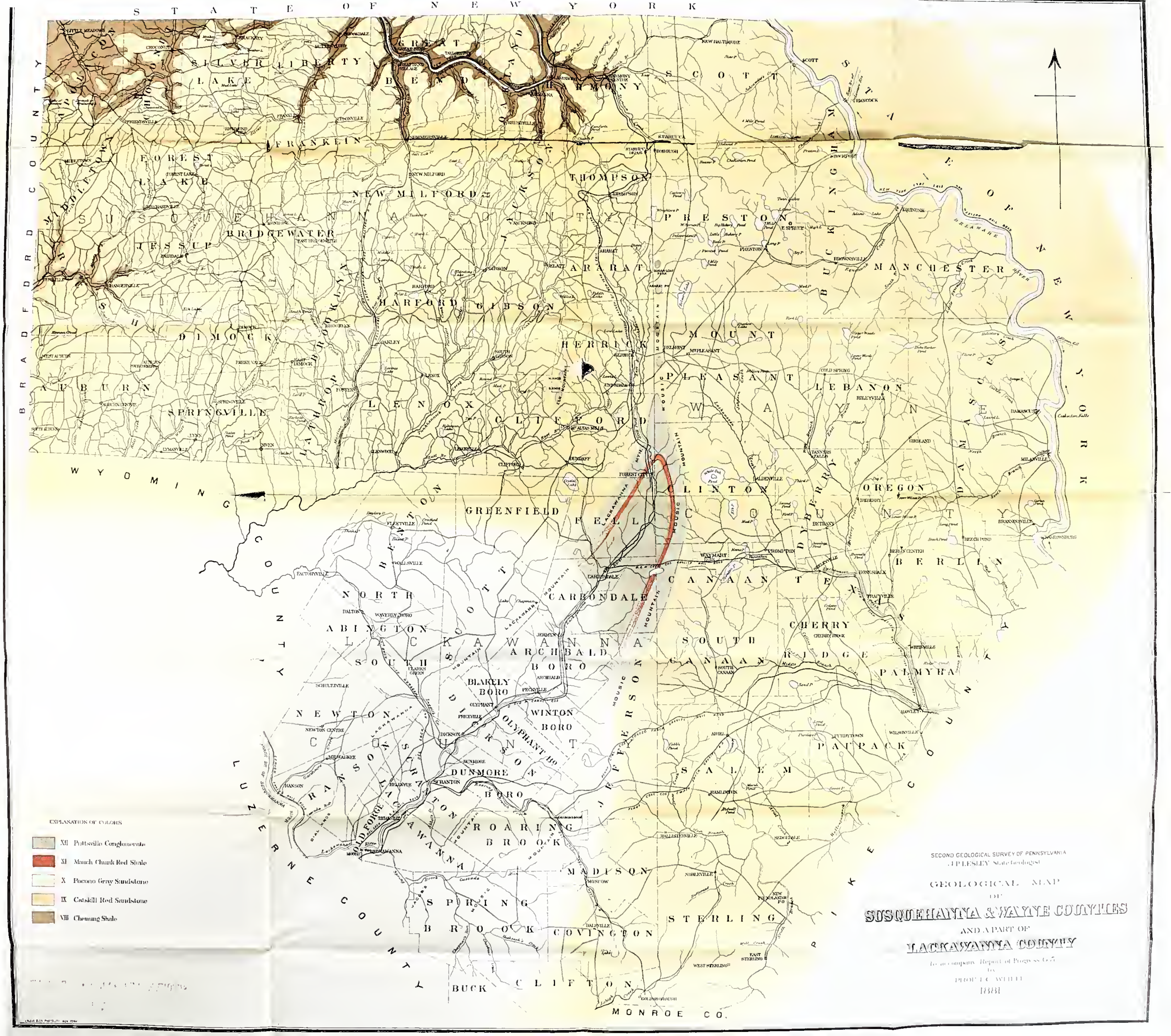

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J. P. LESLEY State Geologist

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OF
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AND A PART OF
LACKAWANNA COUNTY

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